OCTOBER 30, 1961

missiles and rockets

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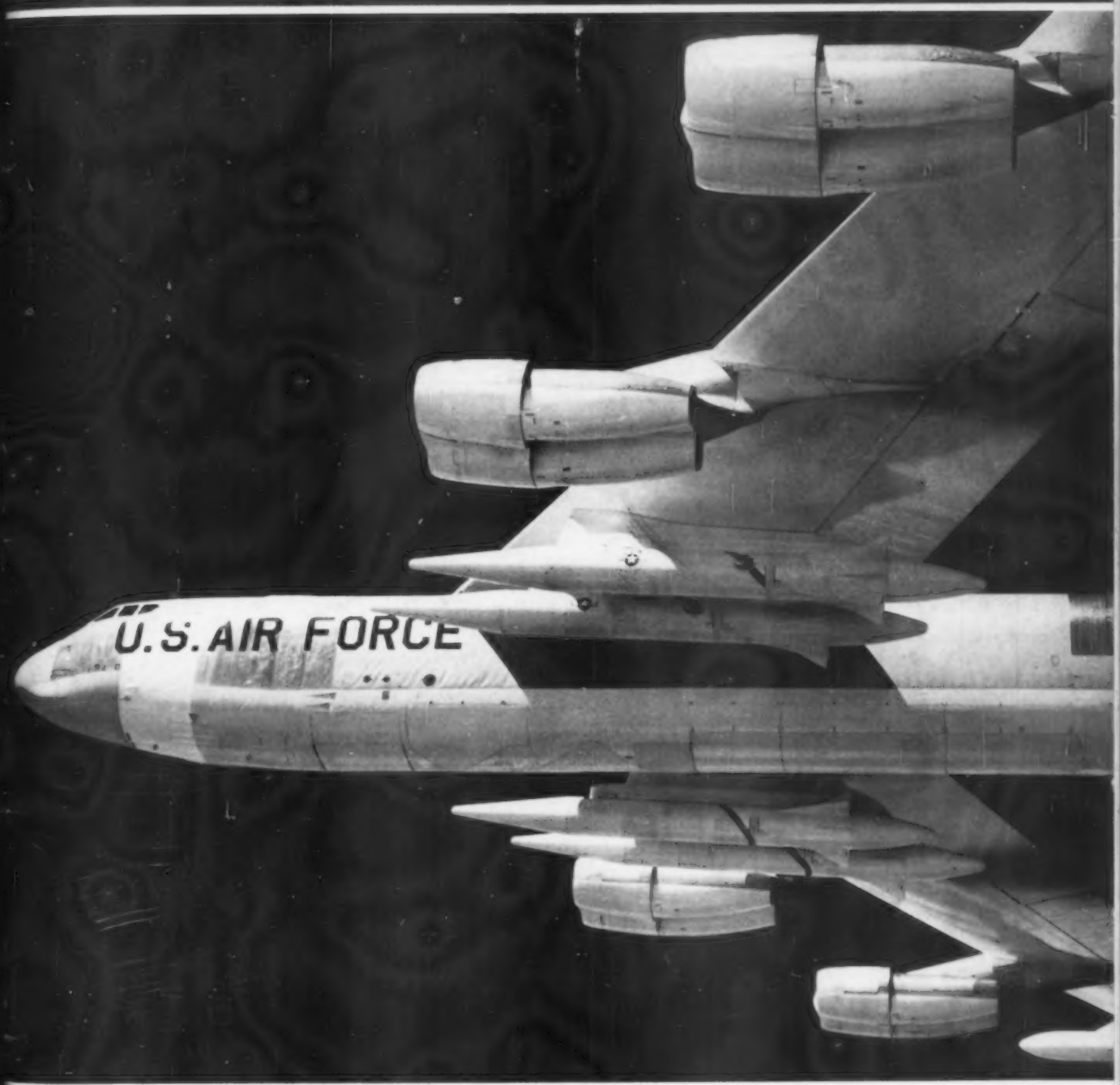
THE MISSILE/SPACE WEEKLY



Newest Skybolt Version on B-52

Analysis: War Deterrent Still Marginal . . .
NASA Building Vast Booster Test Area . .
Solid-State Circuitry Computer Shown . . .

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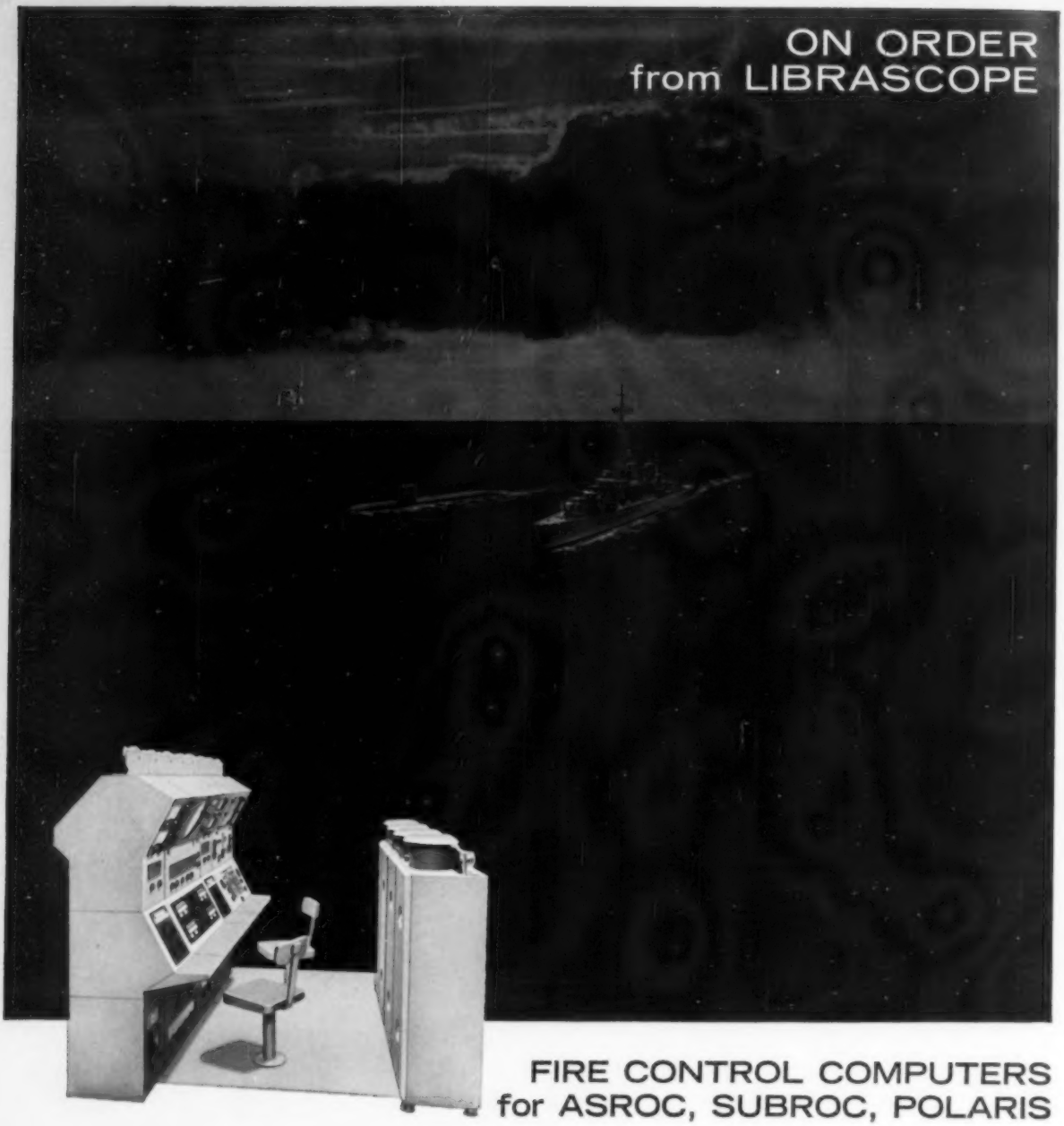

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for ASROC, SUBROC, POLARIS

Two decades ago, the U. S. Navy ordered a compact ballistic computer from Librascope. Contracts for development of Underwater Fire Control Systems MK 104, 105, 107, and 110 followed. Today, Librascope is a logical partner in the Navy's development and production of fire control systems for ASROC, SUBROC, POLARIS and other weapons. Librascope's experience in building computer control systems for military environments is still paying off where it counts—on the front lines of our nation's defense. A note to Librascope outlining *your* control problems will bring a prompt answer from the country's most versatile manufacturer of computer control systems.

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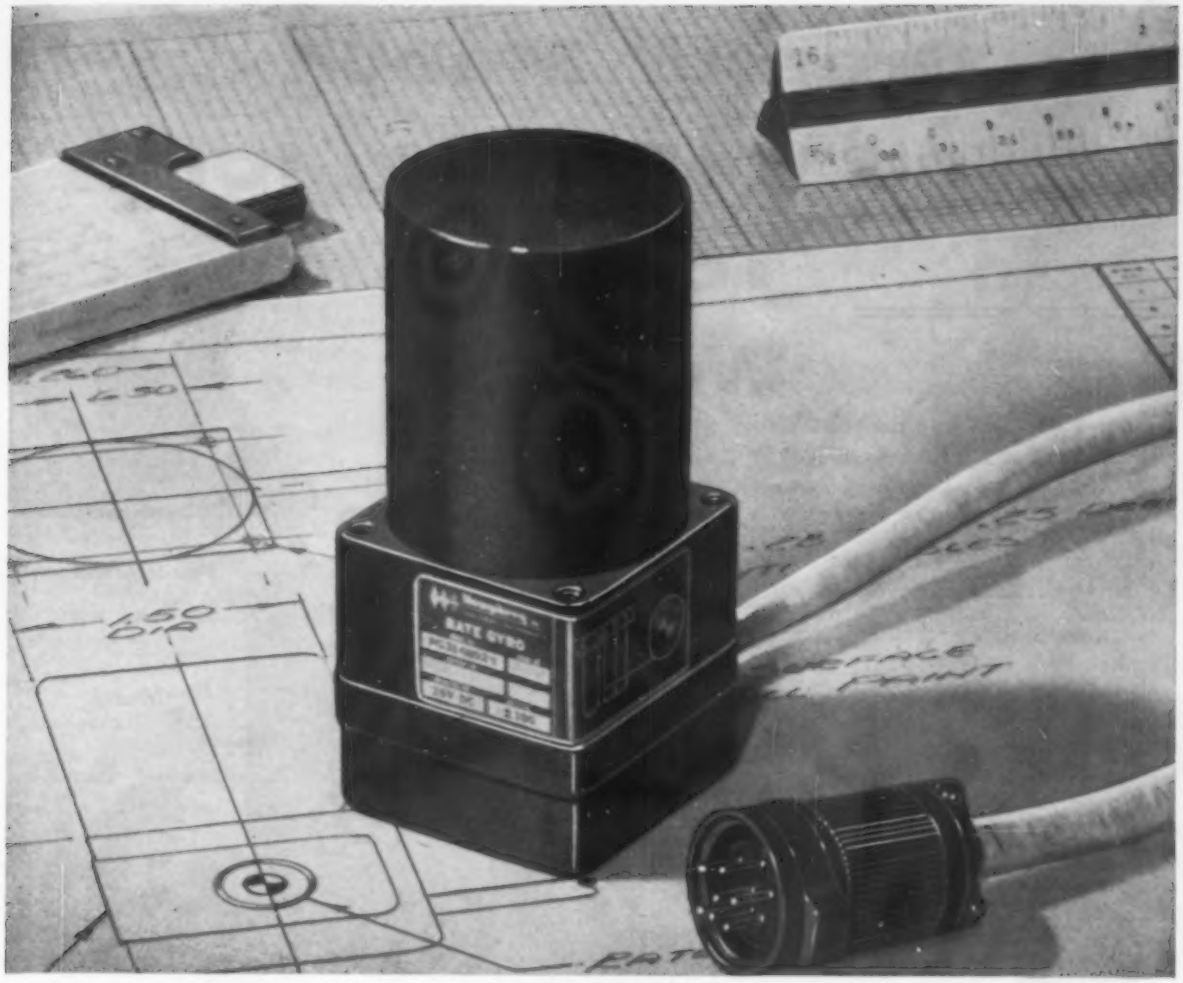
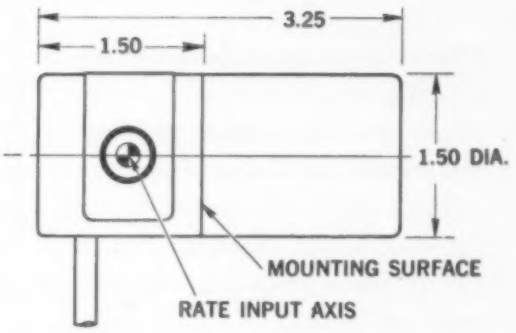


Smallest complete d-c rate gyro

For stabilization and instrumentation systems, Humphrey, Inc. has developed a new sub-miniature rate gyro that saves ⅓ on weight and size. The new RG31 rate gyro weighs only 11 oz and measures only 1½″ diameter by 3¼″ long. It operates on readily-available 28-volt d-c power. The built-in noise filter reduces r-f interference to meet stringent standards of MIL-I-16910A.

This new Humphrey rate gyro features a high-resolution, dual-wiper potentiometer for a strong, usable output signal. A dry gas damper is used to achieve a damping factor of 0.8 ± 0.1. The whole unit is hermetically sealed, including the r-f filter. The RG31 rate gyro is available in rate ranges from $\pm 40°$/second to $\pm 1500°$/second. The simplicity of the straightforward design of this instrument insures outstanding reliability.

Gyro can also be furnished with built-in voltage control oscillator for variable frequency output for direct connection to f-m telemetering transmitter. For more information on the RG31 rate gyro or for help with any of your guidance instrument requirements, write today to Humphrey, Inc., Dept. HMR-1, 2805 Canon Street, San Diego 6, California. Eastern Division is located at 9430 State Rd., Philadelphia 14, Pa. Wichita Division is at 2116 E. Central Ave., Wichita 14, Kan.



Dimensions—RG31 rate gyro

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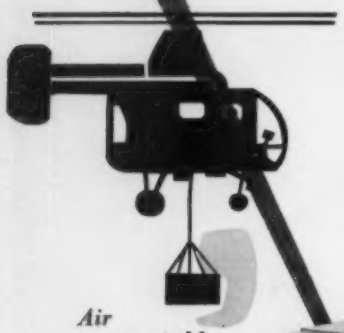

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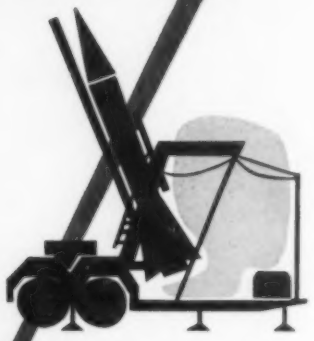

Missile support

Ground checkout

Ground radar

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 18 October 30, 1961

THE COVER

Four inert Douglas Skybolt air-launched ballistic missiles slung under Air Force Boeing B-52H bomber. The system will be tested soon at Edwards AFB, Calif.

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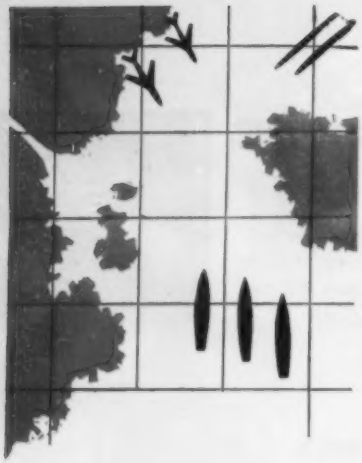

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letters

Counting Heads at ARS

To the Editor:

Hold! Scrub! In M/R Oct. 16 you stated that there were 15,000 at the New York ARS meeting. Last word I had was that there were only around 3000 registrants. Are you reporting (ARS Executive Secretary James J.) Harford's Hopes or reality? Your caption on the front cover should have read "Report from Biggest Bust of an ARS Meeting." Last year's ARS meeting in Washington was really bigger. If you want to report grass roots (or pad roots) feelings, I think that it reflects a growing discontent about too many meetings. Reactions of the non-trade press the nation wide also indicate an "ackish" attitude. You can't orbit a golden egg too often.

Fact Not Fancy

M/R said "more than 15,000 scientists and engineers attended," not registered. ARS says the exact registration was 9111, just halfway between the writer's 3000 and 15,000. In addition, there were 37,000 paid public admissions and close to 15,000 "freebies" (exhibitors, etc.), according to ARS, for a total attendance of around 60,000. Our Oct. 23 editorial expresses our feelings about the overabundance of technical meetings.—Ed.

Russian Boosters

To the Editor:

It appears to me that Mr. Dandridge M. Cole in his article on Red boosters ("Reds May Be Using Saturn-Class Boosters," M/R, Oct. 9, p. 40) has confused *Sputniks VIII* and *XI*. He uses the payloads of the *Venus Probe* and the *Vostoks* interchangeably in his calculations and comments that they probably used the same booster.

According to all the sources I've found, the payload of *Sputnik VIII* was 14,292 lbs. and the *Venus Probe* was 1419 lbs., making a total of 15,711 lbs. of combined payload in one boost. The payload of the *Vostoks* was 10,395 lbs. (*Sputniks XI* and *XII*).

In calculating boost in thrusts, it would appear that there have been three "classes" since *Sputnik III:*

Class A—payload 3000 lbs.—*Sputnik III.*

Class B—payload 10,000 lbs.—*Sputniks IV, V, VI, IX, X, XI & XII.*

Class C—payload 16,000 lbs.—*Sputniks VII & VIII.*

Using Mr. Cole's figure of 70 for a ratio of gross take-off weight to payload weight, and estimating the ratio of take-off thrust to take-off weight to be 1-3, the thrust for Class B would be 910,000 lbs.

Studying some *Atlas* performance figures, it appears to me that 60 would be a more up-to-date ratio. This would give a Class B *(Vostok)* thrust of 780,000 lbs., which is the accepted figure.

Now as to *Sputniks VII* and *VIII*, it appears that this is a *new* breed of booster and probably *not* used for *Vostok* for just this reason (the USSR had five successful type B launchings before *Vostok*). Using the ratio of 60 and 1-3, explained above, the type C thrust would be 1.25 million lbs. As to the number of stages for the *Venus Probe*, it appears to me that part of the *Sputnik VIII* "payload" was used as the rocket for the space probe itself. If we used the "old" module of Class B (10 K lbs.) for guidance, telemetry, etc., 5000 lbs. would remain for this rocket. In this sense it is a three-stage vehicle.

In regards to using a stock 200-K lb. engine, this would give us the following clusters:

Class A—3
Class B—4
Class C—6

Maybe the recent Pacific tests are Class D, with 8 stock engines and approximately 1.6 meg. lb. thrust. This would allow orbiting (in the USSR stock 65°, 150-mi. orbit) a payload of approximately 20,000 lbs.!

In any event it seems certain that Russians have either a booster of approximately 1.25 meg. lbs. thrust or a high-energy-fueled upper stage.

John B. Wilson
RCA Service Co.
Patrick AFB, Fla.

To the Editor:

Dandridge Cole's interesting article leads me to suggest the possibility that the Reds may have been getting around the problem of huge pumping systems by using solid-propellant gas generators instead of these mechanical monsters for pressurizing their liquids.

I was amused by the inadvertent twist of "circumlunar" to "circulmunar" in the last sentence of the article. Could this have been a slip toward "circlemooner"? This reminds me: when are we going to orbit the moon, anyway? This task strikes me as a more important prelude to "Man-on-the-moon" than most people will accept.

A. T. Camp
Assistant Vice President
and Chief Staff Scientist
Grand Central Rocket Co.
Redlands, Calif.

Soldering Education

To the Editor:

I read with great interest your editorial entitled "The Girl With the Soldering Iron" (M/R, Feb. 27). I am also in complete agreement with your thoughts and general philosophy regarding the criticality of wiring and soldering operations performed by personnel on the assembly line.

Recently we developed a formalized training program in soldering techniques for the Baltimore Divisions of Westinghouse. This program has been completely successful. A condensed version of a book that I completed on the program was

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printed in the Sept. 8 issue of *Electronics* Magazine.

The primary purpose for writing, however, is to seek permission from you to incorporate your editorial in the passout material which we give to each trainee at the outset of the 20-hour soldering course. I consider it to be one of the most succinct and effective writings on the subject that I have encountered.

S. W. Mahon
Education and Training
Westinghouse Electric Corp.
Baltimore

Thanks and permission granted.—Ed.

Sound Reduction

To the Editor:

Your Sept. 25 TECHNICAL COUNTDOWN mentions concern about excessive noise on the *Saturn* launch pad due to the use of a dry deflector. Comparisons are drawn to the water-cooled static test facility which experiences a considerable sound attenuation due to cooling water on the deflector. The reporter of this obviously does not know what he is talking about. Unlike on a static test stand, the maximum sound emission at a launch pad occurs when the vehicle is in the air and ascending. Obviously, a water-cooled deflector does not reduce a sound of 204 db total sound power level if the source is 500 or 1000 feet above the pad.

Georg von Tiesenhausen
Huntsville, Ala.

The information in the news item was proffered to one of our editors by a rather important Marshall Space Flight Center official. This man sought out our editor, who was in Huntsville on another matter, because he was worried about rumors that NASA Headquarters was considering eliminating the deflector cooling water.—Ed.

Advanced Thinking

To the Editor:

Many thanks for "Practical Anti-Gravity Still Far Off" (M/R, Sept. 11, p. 28).

The major problems are the enormous amounts of controlled energy required and the very low gravitic permeability of free space.

Feasibility studies in producing matter with much higher permeabilities would seem to be a fruitful field for future "breakthroughs." It may well be that high gravitic permeability is a further property of super-density high-temperature plasma.

Perhaps this is straining the magnetic analogy a bit too far, but the majority of modern electrical items could never have become a practical reality without iron and the high-permeability alloys.

Advanced-thinking articles of this nature are greatly appreciated. May we look forward to one on methods of interstellar communication?

A. T. Lawton
Fairey Engineering Limited
Hounslow, Middlesex,
United Kingdom

You may indeed.—Ed.

GE AND PENNSYLVANIA
KEYSTONE OF INDUSTRY

New Partners in Industrial Growth

General Electric chooses Pennsylvania as the site for its new Space Technology Center

"We made a nationwide study before selecting Greater Philadelphia for our permanent home," says H. W. Paige, General Manager of General Electric's Missile & Space Vehicle Department.

The decision to build this Space Technology Center near Valley Forge was influenced by a number of factors. "We were able to hire many of our 1500 scientists and engineers within a 100-mile radius, and we found an abundance of technically competent small businesses to do subcontract work. Excellent air and surface transportation provides easy access to missile launch sites, defense establishments and other major defense and space contractors.

"The attractive residential communities, outstanding schools, colleges and cultural activities; and Philadelphia's dynamic program of community improvement—which should continue to enhance the area's attractiveness to our professional personnel—also influenced our decision.

"Building this 800,000 sq. ft. center, while continuing to occupy a 600,000 sq. ft. facility in Philadelphia's 'University City' is proof we believe Greater Philadelphia is admirably suited to the needs of a modern research and development business."

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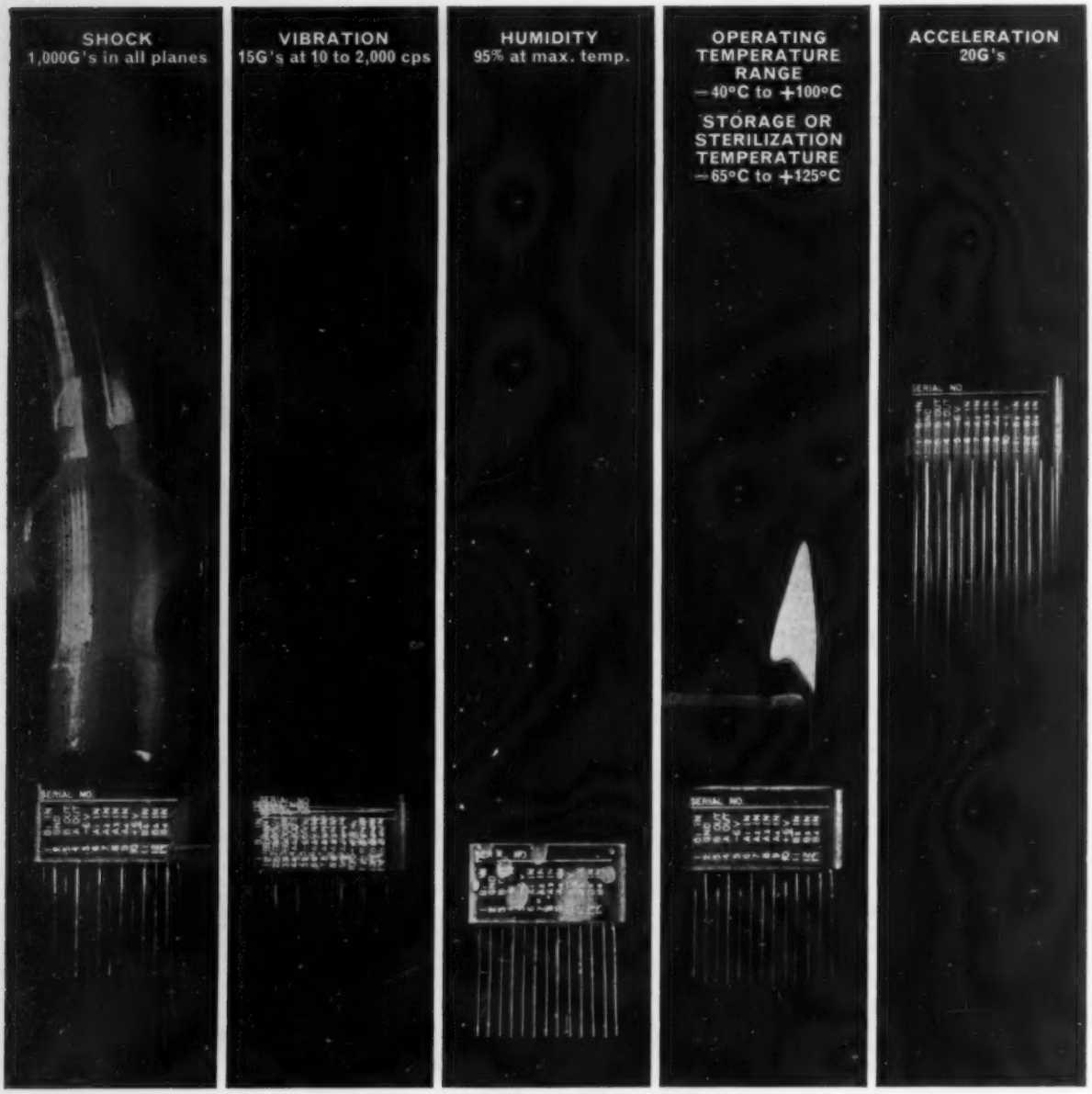

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The Countdown

WASHINGTON

U.S. H-Bomb Atmospheric Tests

Outlook for resumption of missile nuclear warhead tests by the U.S. is now January—next spring at the latest. The U.S. Pacific nuclear test range in the Marshall Islands needs an estimated four to six months to get prepared for new tests. Meantime, it's possible atmospheric tests of smaller weapons could be conducted in Nevada. One of the main reasons for the new tests is checking out the *Nike-Zeus* antimissile missile—including its nuclear warhead. Another: checking out improved warheads for U.S. strategic missiles.

DOD Questions Sergeant's Future

The Defense Department, in surveying all current missile systems for the FY '63 budget, is taking a particularly sharp look at the Sperry *Sergeant*. Some DOD officials are understood to feel the 75-mile-range tactical missile is not needed. *Sergeant* is already in production and scheduled for deployment early next year.

Minuteman: How Many in FY '63?

The final decision on how many additional *Minutemen* will be included in the FY '63 budget is still open. The debate is reported to have narrowed to whether two squadrons or none will be added to the 12 already authorized through the current fiscal year. One possibility is that even though more production is not included in the budget additional silos will be as a form of insurance.

Bomarc B's North of the Border

The first operational Boeing *Bomarc B's* are being deployed at Royal Canadian Air Force bases in Canada. Two squadrons—28 missiles apiece—are being delivered to the bases at North Bay and La Macaza, Quebec. A total of six *Bomarc B* squadrons are being deployed in the continental United States.

Ranger II Slips Further

The launching of NASA's *Ranger II* space probe has slipped at least a month, into November. The slippage is reported to have been caused by hydraulic system difficulties in the *Agena* second stage of the *Atlas-Agena* boosters used in the program. The first launching of a *Ranger* failed in August.

INDUSTRY

NASA Seeks To Spread Space Work

The national space administration wants to increase the number of space contracts let with firms in the Midwest, Southwest and Rocky Mountain Area. A $250,000 contract has been signed with the Midwest Research Institute in Kansas City, Mo., to inform NASA of the industrial capability of the three regions.

Contracts for Shrike

The Navy has begun to let contracts on its new *Shrike* missile system, formerly known as *ARM*. The air-to-surface anti-radiation missile has been under development by NOTS, China Lake, Calif. However, Texas Instruments has now been chosen to provide developmental guidance and control assemblies for the *Shrike* system. Size of contract: $1,570,504.

Scramble at Jackass Flats

A hot industry competition is on for the NASA contract to build a second nuclear rocket engine test stand at the National Nuclear Rocket Development Center in Nevada. Twenty-two firms have submitted bids for the job. Value of the contract: about $8 million.

Anti-negotiated Contract Bill Readied

The House Armed Services Investigations Subcommittee is preparing legislation aimed at curbing negotiated procurement. The bill is scheduled to be presented to the full committee for action in January. Subcommittee studies show that more than $8 billion in sole-source procurement contracts were let by the Pentagon over the last two years.

Just Dial Telestar

AT&T has decided on a name for its R&D communication satellites which NASA will begin launching next year. They will be called *Telestars*. Plans now call for launching four of them.

INTERNATIONAL

French 'Precious Stones'

France is now hopeful of orbiting a satellite weighing from 110 to 175 lbs. by 1963-64 period, using a combination of rockets named after precious stones. The big boosters go under the names *Emeraude, Saphir* and *Diamant*, weighing upwards of 25 tons, measuring 29 ft. in length or more and liquid-fueled. Uppers stages would be solid-fueled.

Reluctant Swedes

Sweden is understood to be unhappy about joining the European *Blue Streak* project because it lost out to West Germany in building the third stage. Sweden wanted to use its Flygmotor *VR-3* for the job, while West Germany has no hardware.

Overseas Pipeline

Russia is reported to have set up a new Laboratory of Bio-Telemetering Engineering for man-in-space. . . . Creation of a National Center for Space Research (counterpart to NASA) with an initial yearly budget of about $17 million has won approval in the French National Assembly. . . . In Britain, Schlumberger Inc. is acquiring a majority interest in the big Solartron Electronic Group Ltd. for about $5.5 million from Firth Cleveland.

The Missile/Space Week

Shots of the Week

The Navy *Polaris* and Air Force *Midas* took significant forward strides last week.

- For the first time, a 1500-mile *Polaris A-2* was fired from a submerged submarine, the Ethan Allen. The flight of the 30-ft. missile on Oct. 23 appeared to be successful. But there was no confirmation from the Navy, under a DOD-imposed secrecy rule.
- A *Midas IV* satellite fired into orbit from Vandenberg AFB, Calif., Oct. 21 reportedly detected the exhaust of a *Titan* launched Oct. 24 from Cape Canaveral within two minutes of ignition. Test results of the infrared missile warning system again were kept secret.
- The *Atlas-Agena B* which launched *Midas IV* also carried piggy-back into orbit a 75-lb. package containing 350 million copper dipoles in the Project *West Ford* radio communications experiment. (See photo.)
- On Oct. 23, the Russians fired their seventh large booster rocket into the Pacific.
- The Air Force failed to orbit *Discoverer XXXIII* on Oct. 23 when the *Agena* second stage apparently shut down prematurely.

Nuclear Rocket Flight Test Seen Possible by 1966-67

Dr. Glenn T. Seaborg, AEC chairman, predicted this week that the first flight tests of a nuclear-powered *Nerva* rocket could be conducted by 1966 or 1967.

He said the *Nerva* upper stage could increase the payload of a *Saturn* booster two or three times.

AEC recently awarded contracts to Aerojet-General and Westinghouse to develop the first *Nerva* engines.

Rauth Heads Titan Push

J. Donald Rauth, Vice President of Martin Co.'s Nuclear Division, has been named to head the firm's entire *Titan* missile development program.

Rauth will make his headquarters in Denver and will report directly to Martin Co. President William E. Bergen. He will supervise research and development, flight testing, base activation and final checkout and delivery of all *Titan* missile and space booster systems.

The Martin Co. has also announced that it has changed the name of its Cocoa Division in Cocoa Beach, Fla., to the Canaveral Division.

Apollo Effort Appraised

The National Science Foundation has launched a study to determine whether the nation might be pouring too much of its resources and skilled manpower into the *Apollo* program.

This was disclosed by Dr. Alan T. Waterman, Foundation Director, who said that the study would seek to learn whether emphasis on landing an American on the moon by 1970 might deprive such key projects as cancer research of needed resources.

The study will be made by the Foundation's new Science Resources Planning Office.

Foundation officials report that the study will continue for several years, with the first results due in a few months.

It is being made under broad legislative authority which empowers the Foundation to report to government agencies on the scientific capability of the U. S.

West Ford Dipoles—Did They Orbit?

SUCCESS OF FIRST Project West Ford experiment was in doubt last week as the Air Force reported that radar had failed to pick up the band of 350 million dipoles supposedly dispersed in space (see diagram above). There was a possibility they were not ejected from a package carried piggy-back by Midas IV Oct. 21.

Screening Space Data

A way to compress a vast amount of space-derived data into compact form for transmission to ground stations is being developed by IBM scientists.

The scheme is to transmit data "by exception." If a satellite is sent aloft with a sensor which measures space radiation, the data transmitter can be instructed to stay off the air until it recognizes that it is getting radiation readings exceeding pre-set limits.

"In transmissions using the data-compaction techniques, redundant information is removed from the messages before they are broadcast from the space vehicle," according to Dr. Herman Blasbalg of the Federal Systems Division's Communications Systems Center. "Only the essentials are transmitted."

Blasbalg confirmed that by means of such advanced message-coding techniques, more data can be transmitted from a space vehicle than has ever been possible—and less of the already crowded radio spectrum needed.

U.S. 7 Points for Space

The Kennedy Administration has proposed a seven-point program to guarantee peace and world cooperation in space.

The program—which will be presented to the United Nations—calls for:

—Explicit confirmation that the UN Charter applies to limits of space exploration.

—A declaration that space and heavenly bodies are not subject to claims of national sovereignty.

—An international system of registering all objects launched into space.

—A specialized space unit in the United Nations Secretariat.

—A world weather-watch using satellites.

—A cooperative search for ways to modify weather.

—A global system of communications to link the world by telegraph, telephone, radio and television.

Russians Propose Earth Halo

Two Soviet scientists have suggested creating Saturn-like rings in space around the earth in order to modify weather on a grand scale.

Their idea, involving the orbiting of several hundred thousand tons of powder, was described in a recent issue of the Soviet Economic Gazette.

"Let us assume that we are able to create a ring around our planet something like that around Saturn," the two scientists said.

"If the particles that make up this ring reflect sunlight well enough, then intelligent orientation of this unique mirror might change the climate of many regions of the earth in the desired direction."

Epilepsy in Space?

Evidence that astronauts may become temporary epileptics in certain circumstances due to vibrations and accelerational forces of rocket boosters is reported by UCLA's Brain Research Institute.

The Institute said that deep electroencephalograms were made while monkeys and other animals were subjected to acceleration and vibrational effects during centrifuge and shaker apparatus experiments. The recordings, made with a special transistorized unit designed for satellite biopacks, showed erratic electric discharges from the temporal lobe area of the brain characteristic of epilepsy.

Dr. Ross Adey said this suggested that extreme vibrations drive the normal rhythms of the brain to abnormal discharges. The effect probably is only temporary, but it could prove critical in an astronaut's performance in space.

New NASA Info Post

NASA has appointed Dr. Hiden T. Cox assistant administrator for public affairs.

Cox, currently director of the American Institute of Biological Sciences (AIBS), will assume his new position on December 1, 1961. Reportedly, the appointment is a temporary one.

The new office in NASA stems from Administrator James E. Webb's belief that NASA must improve its communications with the American public and Congress. Cox will be responsible for directing and coordinating policies and activities concerning dissemination of information, educational programs, and relations with other governmental agencies, universities, and industrial research.

Department Head—Aerothermodynamics

This new position is currently available in our Engineering Sciences activity. We are seeking an outstanding scientist who has the stature and maturity to provide technical leadership for a small group of highly qualified aerothermo specialists performing studies concerned with advanced rocket propulsion systems.

The position requires a high degree of creativity. Selected candidates will possess a record of major responsibility and accomplishment in this field, and will be thoroughly knowledgeable in analysis and test work. An advanced degree, preferably a doctorate, in mechanical or aeronautical engineering with a minimum of five years experience is required.

This is a stimulating, challenging position with recognized professional leaders at UTC's modern multi-million-dollar complex, where the very latest techniques, methods, ideas and equipment are available. UTC is located in the San Francisco Bay Area, which features "West Coast living" at its finest.

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despite reassurances . . .

Kennedy War Deterrent Remains

Analysis shows U.S. is passing up opportunity to seize offensive—if downward estimate of Red ICBM power is correct

THE KENNEDY Administration is staking the nation's security on a strategy of marginal deterrence despite claims this week of overwhelming nuclear power.

Moreover, for the fourth time since the end of World War II, an administration is declining—at least to date—to seize an apparent opportunity to build or employ strategic military might for taking the offensive in the Cold War.

It is against these hard truths that the widely publicized new explanation of Administration defense policies by Deputy Defense Secretary Roswell L. Gilpatric must be measured.

Gilpatric's words also must be measured against the background of three new and hardly calming Soviet military developments within the week:

—The detonation in the Arctic on Oct. 23 of a huge nuclear bomb with a force of more than 30 megatons and the previous Soviet announcement that Russia has in its possession a 100-megaton bomb. Two hours after the first blast, the Russians detonated a low-yield nuclear bomb underwater in the Arctic, probably testing an anti-*Polaris* sub weapon. On Oct. 25 they detonated another multimegaton bomb in the Arctic, bringing the total number of tests in the current series to 24.

—The launching on Oct. 23 into the Central Pacific of the seventh multi-stage missile in the current Soviet test series involving 7500-mile flights of new big boosters.

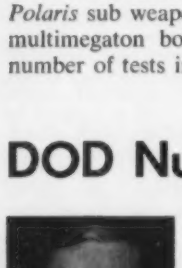
—The boast by Soviet Defense Minister Rodion Malinovsky, also on Oct. 23, that Russia has solved "the task of destroying missiles in flight." At the very least, Marshal Malinovsky's statement added considerable weight to Army intelligence reports that Russia is working hard on the development of an antimissile missile system.

• **Party line**—The importance of Gilpatric's policy explanation presented in an address Oct. 21 before the Business Council at Hot Springs, Va., is beyond question. It was reliably reported to have been approved in advance by President John F. Kennedy and Secretary of State Dean Rusk as well as Defense Secretary Robert S. McNamara.

Accordingly, Gilpatric's address is nothing less than the Administration's "party line" on defense matters.

Gilpatric's principal theme was that the Administration by building up the nation's limited war forces is is increasing the flexibility with which the President can respond to Soviet moves in the Cold War. At the same time, Gilpatric sought to assure America and the world

DOD Nuclear Claim: 'Tens of Thousands'



Here is the text of Deputy Defense Secretary Gilpatric's Oct. 21 "explanation" of U.S. defense policy. Calming statement reportedly was personally okayed by President Kennedy.

IT HAS BEEN my observation that the only way to keep the Government's defense policy clear in the minds of those not in Government is by constant reiteration

Inevitably, in the course of public discussion, misinterpretations and misunderstandings of defense policy develop. It may be because we in Government fail to make ourselves clear in the first place. Perhaps we take it too much for granted that having once stated a policy we have fulfilled our task of achieving public understanding. Or perhaps the subject is so complex that it requires a continuing dialogue between the Government and the people.

Whatever the reason, I am convinced that we have not yet succeeded in getting across to the public at large a full understanding of the defense policies we are now pursuing. Even for such well informed individuals as yourselves, it could be worthwhile for me to restate our defense objectives and what we are doing to achieve them.

Twice in this century we have gone unprepared into global conflicts and then waited until the war potential of our economy could be called upon to see us through. Today, now that quick nuclear destruction has become possible, we can no longer place such reliance upon long-range potential and second chances. We therefore plan to obligate, in this current fiscal year, about $50 billion for military readiness and civil defense, the largest security expenditures for any peacetime year in our history.

This figure is an increase of $6 billion above a year ago, and $9 billion higher than the year before that. Actual expenditures, which will rise to about $47 billion this year, can be expected to climb still higher in subsequent years unless we achieve significant reductions in the world's international tensions.

(Continued on page 36)

s Marginal

by James Baar

Combat Atlas E raised from new Forbes AFB semi-hard launcher

that the United States was in no way weakening its nuclear deterrent power.

It was in giving this assurance that many considered Gilpatric's address most revealing—and most comforting. However, few noted that some of the principal components of the proffered balm were half-truths.

"The fact is that this nation has a nuclear retaliatory force of such lethal power that an enemy move which brought it into play would be an act of self-destruction on his part," Gilpatric said, leading into the heart of his address.

"The U.S. has today hundreds of manned bombers capable of reaching the Soviet Union, including 600 heavy bombers and many more medium bombers equally capable of intercontinental operations. . . . The U.S. also has six *Polaris* submarines at sea carrying a total of 96 missiles and dozens of intercontinental ballistic missiles. Our carrier strike forces and land-based theater forces could deliver additional numbers of megatons. The total number of our nuclear delivery vehicles, tactical as well as strategic is in the tens of thousands; and of, course, we have more than one warhead for each vehicle."

Then Gilpatric added:

"Our forces are so deployed and protected that a sneak attack could not effectively disarm us. The destructive power which the United States could bring to bear even after a Soviet surprise attack upon our forces would be as great as—perhaps greater than—the total undamaged force which the enemy can threaten to launch against the United States in a first strike."

• **Dissection**—The overall effect of the Deputy Secretary's words is certainly one of reassurance to the casually informed American voter and the even more casually informed camel drivers of the world. But, when closely examined, the claims are found to be far less impressive and considerably misleading.

Gilpatric's listing of strategic deterrent power included "our carrier strike forces and land-based theater forces." The land-based theater forces comprise the *Thor* and *Jupiter* IRBM's deployed in Europe as well as *Matadors* and *Maces*, fighter bombers and the bulk of the medium-range bombers deployed around the Soviet Empire's periphery. Unfortunately, the Russians have long been credited with a sufficient stockpile of IRBM's and MRBM's to wipe this entire force from the board on a first strike.

As for the attack carriers, there are five deployed in advance positions from which a retaliatory blow of a relatively small number of bombers could be mounted. However, whether the carriers in advanced positions would survive the initial attack is debatable.

Gilpatric spoke of "tens of thousands of nuclear delivery vehicles, tactical as well as strategic." Such a number has little to do with strategic deterrent force. Well over 90 percent of a total of this size is made up of short-range tactical weapons.

Gilpatric spoke of "six *Polaris* submarines at sea carrying a total of 96 missiles." However, only five *Polaris* submarines carrying a total of 80 missiles have been deployed to date. And, of these, one or more is undergoing resupply and refurbishing at Holy Loch, Scotland.

Gilpatric spoke of "dozens of intercontinental ballistic missiles." The United States today has 45 operational *Atlas* ICBM's deployed in soft and semi-soft launchers at bases in five states. Only a part of this force is ready to fire within 15 minutes at any one time.

Gilpatric spoke of "600 heavy bombers and many more medium bombers equally capable of intercontinental operations." Actually there are about 570 B-52 intercontinental jet bombers and only several hundred medium bombers based in the Western Hemisphere.

Therefore, despite Gilpatric's "tens of thousands of nuclear delivery vehicles," U.S. deterrent power outside the range of Soviet IRBM's and MRBM's is comprised mainly of the SAC B-52 bomber fleet, several hundred medium bombers and a total of less than 100 *Polarises* and *Atlases* "in the green."

The destruction of this force would not take an enormous number of Soviet ICBM's and submarine-launched missiles. Less than about 400 Soviet missiles capable of reaching the United States would be more than enough to disable everything except for those bombers able to get off the ground in time, the small bomber force on airborne alert and the three or four *Polaris* submarines on station. The surviving bomber force then would suffer further losses running the formidable Soviet air defenses.

As late as the first months of this year, some U.S. intelligence estimates forecast that the Russians would have 300 or more ICBM's by January, 1962, and possibly 1000 by January, 1963. Soviet ICBM production

(Continued on page 40)

From own staff . . .

NASA Discloses New Apollo Bosses

Golovin, Lowe, Roadman and Rosen to head major groups; program office line-ups are amplified

NASA's super-management office for the *Apollo* program will lean heavily on current space agency personnel to fill its top positions.

Only one top job in the Office of Manned Space Flight—that of deputy to Director B. Brainerd Holmes—remains to be filled. It is considered likely that an industry official will be tapped for the position.

Directors of all of the four major management groups within the office, however, will be filled by NASA officials including:

—Dr. Nicholas Golovin, currently chairman of the joint NASA-DOD committee which is considering future U.S. space programs will serve as director of systems engineering for all spacecraft and launch vehicles in the *Apollo* program.

—George M. Lowe, currently head of the Manned Space Flight Office at NASA headquarters, will be director of Manned Spacecraft and Flight Missions, primarily concerned with development of the *Apollo* spacecraft and advanced *Mercury* spacecraft for advanced manned earth-orbiting missions.

—Gen. Charles H. Roadman, an Air Force officer assigned to NASA, will serve as director of the Office of Aerospace Medicine.

—Milton R. Rosen, now assistant director of launch vehicle programs, will serve as director for Launch Vehicles and Propulsion, responsible for development of the *Saturn* and *Nova* class vehicles which will be used in the lunar program.

• **Four firm offices** — The *Apollo* management was disclosed as the space agency released further details of its reorganization into four program offices. NASA expects to hire approximately 300 more people for the moon office, but these will be primarily in lower positions. While Holmes will probably refine the management setup for the Office of Manned Space Flight, the organization of the other offices is firm.

A breakdown:

• The Office of Space Sciences will be responsible for all unmanned exploration of space, the moon and the planets. Its director will be Dr. Homer Newell. His deputy will be Edward Cortwright, currently head of NASA's Lunar and Interplanetary program. It will have a launch vehicle and operations group headed by Air Force Col. Don Heaton which will be responsible for development of the *Centaur, Agena, Delta* and *Scout* launch vehicles. Other groups within the office include Grants and Research Contracts, headed by Dr. Tom Smull; Geophysics and Astronomy, position vacant; Lunar and Interplanetary programs, Oran W. Nicks; Bio Science programs, probably Dale Smith. All of the latter are current NASA personnel.

• Office of Applications will be responsible for the communication satellite and weather satellite programs. No director has been named. John Burke, a Siegler Corp. executive, was offered the job but has declined. Three other industry officials are being considered.

The rest of the major positions in the office—with one exception—will be filled by current NASA personnel including Mort Stohler as Deputy Director, Dr. Morris T. Tepper as director of Meteorological programs, and Leonard Jaffe as director of communication satellite programs. A Director of Future Applications—to be responsible for finding ways of getting the results of NASA R&D into the market place—has not yet been selected.

• The Office of Advanced Research and Technology will control the *Rover* nuclear energy programs, *Snap*, and the development of all other advanced research programs. Its director will be Dr. Ira Abbott. A deputy has not been appointed, but he will come from NASA.

The rest of the Office's breakdown includes: Director of Nuclear Energy, Harold Finger; Director of Aeronautical Research, John Stack, currently assistant director of the Langley Research Center; Director of Research in the fields of Chemistry, Physics, etc., Dr. H. H. Kurzweg; Director of Electronics and Control, Dr. Al Kelly. Two positions—Director of Propulsion and Power Generation and Director of Space Vehicles—have not been filled.

• **One switch**—When NASA announced preliminary details of its reorganization last October, the Space Agency said that Thomas F. Dixon, deputy to Associate Administrator Dr. Robert C. Seamans, Jr., would direct a small management group to run the development of all small launch vehicles.

Instead, that program has been placed under the Office of Space Sciences.

NASA officials report, however, that Dixon will continue to keep a close eye on the small vehicle development, principally because of the eight-month slippage in development of the *Centaur* vehicle.

Technical difficulties with the *Centaur* engine have forced NASA to cut drastically the size of the *Mariner* spacecraft which will be launched next year with a *Centaur*.

It has also raised the possibility that the *Advent* communication satellites may have to be launched with another vehicle or delayed. Approximately four *Centaur* development flights are scheduled next year, with the first slated for early in January. ¤

NASA Buying Huge Test Facility

Mississippi setup for static-firing big boosters may cost $400 million eventually

by Hal Taylor

NASA WILL SPEND over $200 million for a massive static test-firing facility for large space boosters which will be located in Southwest Mississippi.

Space agency officials said that the cost of the facility—which is expected to be completed in about three years—could ultimately total $400 million.

The facility—on which at least six static test stands for *Nova* and *Saturn* vehicles will be built—will be 400 sq. mi. in area, twice the size of the recent expansion of Cape Canaveral.

This will include 13,500 acres of land on which the facility will be built. In addition, 128,000 acres including 103,000 acres in Pearl River and Hancock Counties in Mississippi and 25,000 acres in St. Tammany Parish in Louisiana will be acquired as a buffer zone for the noise created by the firings.

Land acquisition costs will total $13.5 million. The cost of blockhouses, test stands, support buildings and equipment will run the cost initially to at least $200 million. Later expansion is expected to push the figure much higher.

NASA said at least six test sites will be built with two stands on each. The first ones to be built will be used to test the follow-on version of the *Saturn* booster which will probably be the *C-4*, developing 6 million lbs. thrust. Other stands will be built eventually for the *Nova* superbooster, which will develop 20 million lbs. thrust. It is also likely that large upper stages of the *Saturn* and *Nova* boosters will be test-fired at the facility.

NASA is also considering building a "multiple-use" test stand which could be used to test-fire several different types of boosters.

It is also probable that the site will be used for the test firing of large solid-propelled boosters as well as liquid versions.

The Pearl River Area was one of 30 sites considered for the facility in the Gulf Coast area. It is only 35 miles from the Michaud, La., plant where the *Saturn* class of launch vehicles will be built. There is also the possibility that the *Nova* vehicle will also be built there. The alternative is a new plant in the same general area.

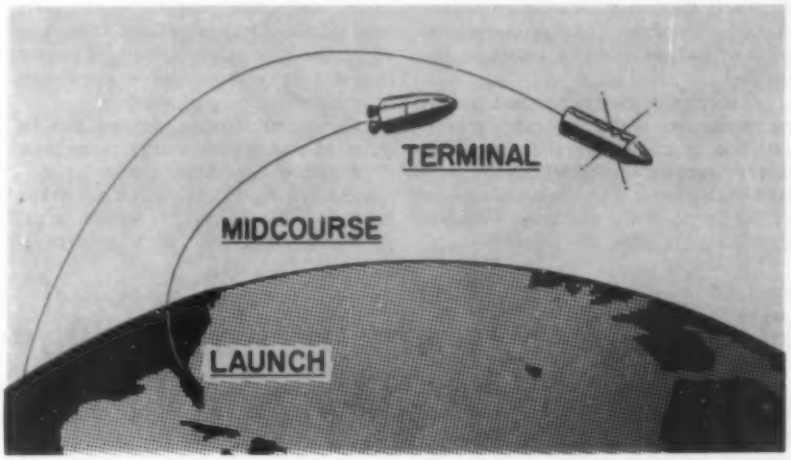
The static test-firing facility will employ 500 to 1000 scientists and engineers who will be under the direct supervision of the Marshall Space Flight Center in Huntsville, Ala.

One of the prime criteria in the site selection was access to deep water. The Pearl River area will supply water-borne booster transport to the Michaud plant via the Pearl River and Intercoastal Waterway.

Space agency officials said construction will begin next spring.

The officials said that the ultimate size of the facility and the types of test stands that will be built will depend upon further developments in the U.S. manned space flight programs.

Part of the decisions will hinge on the report of a joint NASA-DOD committee now considering the best methods, launch vehicles and spacecraft for the U.S. Space Program. As a result, firm decisions on the types of test stands will not be made until after the first of the year. ¤



Rendezvous Recommendation Imminent

A TOP-LEVEL DOD-NASA committee will shortly recommend that the U.S. pursue the "space rendezvous" concept as a chief means of achieving a manned lunar landing.

The group's report to President Kennedy on the long-term goals and needs of the U.S. space program was scheduled to be completed last week, but will be delayed until sometime in November (M/R, Oct. 9, p. 16).

It has also been learned that the committee will probably also recommend that NASA build the *Saturn C-4* with four F-1 engines as the next large booster.

The committee and the Marshall Space Flight Center estimate that the *C-4* will take from three to six months longer to develop than the earlier concept of a *Saturn C-3* with two F-1 engines. Other NASA officials contend, however, that it could delay development as much as 1½ years.

All of the vehicles would be used for "rendezvous," calling for mating craft in space orbit for long flights to the moon. One NASA concept (see picture above) involves mating the vehicles while in earth orbit. ¤

At Thiokol . . .

Liquid Bullpup Motors in Production

BRISTOL, PA.—Packaged liquid engines for the Navy's *Bullpup* air-to-ground missiles are rolling off Thiokol Chemical Corp. production lines under a $4-million initial production contract.

The engine, designated LR58, is extremely simple in design with only one moving part. Thiokol engineers say it is capable of scale-up to virtually any size.

Production equipment and machine tools are standard. The entire line is geared for a station-to-station transfer time of 20 minutes. The major emphasis is on quality control.

In one instance, sections of the LR58 headed for welding operations must have been thoroughly cleaned no more than four hours before. Zyglo and X-ray facilities are an integral part of the line.

• **Component parts**—The oxidizer, inhibited red fuming nitric acid, and a mixture of amines are stored in an aluminum tank shell. A solid-propellant charge furnishes the pressurization medium and an initiator complete the missile.

A combination injector and initiating mechanism is the only moving part. Initiation is caused by shearing a set of cups separating the hypergolic propellant elements. The cups themselves are set in carefully machined injection ports which regulate the liquid flows.

RING OF shear cups in the initiator and mixing section of the liquid Bullpup engine passes rigid inspections.

Thiokol's production facility includes loading—so that the engines leave ready for operational use.

The prepackaged engines have all the handling characteristics of a solid-fueled unit. The propellants are inert until mixed. Drop tests from as high as 40 ft. have been performed. Extreme temperature or atmospheric conditions have no effect on performance.

Thrust termination devices can be included and higher energy propellants used without significant design or production changes. Martin Co., prime contractor for the *Bullpup* system, credits the liquid engine with greater reliability, versatility and range than the currently operational solid *Bullpup*.

The *Bullpup* is radio-controlled by the pilot of the launching aircraft. Thiokol's liquid engine is essentially smokeless, making the weapon difficult for an enemy to spot. Two tracking flares installed in the aft fairing aid the pilot in guiding the missile to its target.

• **New control system**—A nuclear *Bullpup* (GAM 83B) is under development by the Air Force. Because of blast effect, an offset launch system has been perfected. This will permit the pilot to guide a nuclear *Bullpup* to a target from an offset position instead of following the weapon towards its target in a dive.

Value analysis programs at Martin have reduced the cost of production *Bullpups* well over 50%. The weapon costs less than any other comparable missile to destroy a majority of tactical targets.

Engines for *Bullpup "B"*, a larger, more advanced version, are in development at Thiokol's Reaction Motors Division under a $1.033-million contract.

Development and PFRT of the LR62 (*Bullpup "B"* engine) has been completed and the engine is now undergoing MIL Spec qualification testing. Ballpark range figures for the *"B"* missile are 9 to 10 miles. ⠿

Electronic System Improves Navy Solids

INDIAN HEAD, Md.—A unique electronic combination of an automatic data acquisition system and computer complex (ADACC) has enabled the Naval Propellant Plant here to substantially increase the production of solid propellants for *Polaris* and other Navy missiles.

Revealed for the first time last week, the system consists of an RCA 501 computer and an Interstate Electronics Corp. data-gathering unit which made it possible to instantaneously calculate propellant and motor performance.

The ADACC system—the only one of its kind, according to the Navy—accepts information directly from a rocket motor in the firing bay while at the same time performing the analysis of the rocket motor's firing characteristics.

Supplementing ADACC, the propellant plant has been equipped with an automatic data recording system to collect data from the firings of small charges of solid fuels. This information is fed into the 501 computer and in less than a minute evaluation of the fuel's performance is finished—a task that formerly took 40 to 80 man-hours.

In addition to providing almost instantaneous information to the firing officer during the test, the ADACC system performs follow-up calculations that would take weeks by other means. This capability, according to the Navy, enables changes to be made in the fuel mixtures which in turn improve the motors or propellants before they come off the production lines.

During a firing, the computer checks the motor's pressure, temperature and thrust every .006 seconds. If the system receives signals denoting unusual conditions, it sends warning signals to the firing officer through the data-gathering system. However, if a critical point is reached, the computer is programed to automatically shut the test down.

In addition to processing propellant and motor tests, the 501 computer is used to calculate missile trajectory data, heat transfer, burning rates and other complex problems. However, when a firing test is scheduled, the computer interrupts any other problem that it has been working on and stores the information on magnetic tape.

After it has checked out the firing equipment and processed the data from the firing test, the computer automatically returns to the stored problem.

With the addition of ADACC, Capt. Otis Wesche, commanding officer of the plant, stressed that the Navy's potential for improving solid-propellant motors has been greatly enhanced. ⠿

Morale booster . . .

DOD In-House Labs Win 'Primary' Role

IN-HOUSE DOD laboratories are being up-graded to a "primary" role in carrying out new weapons development.

The question seems to be, how primary is "primary"? Or if it is largely a morale gimmick.

The new measure of responsibility, ordered by Defense Secretary McNamara in an Oct. 14 memorandum, conceivably could bring about some head-on collisions with "non-profit" and industrial laboratories and organizations presently overseeing the management of many weapons programs—if the labs grab the initiative.

In any event, there seems to be little doubt that the lines of authority for the "non-profits" must be re-drawn somewhat to permit the in-house labs to take over a greater management role. This was made clear last week by Harold Brown, director of defense research and engineering, who summed up the problem in a Naval Research Laboratory talk:

"These non-profit laboratories are a tremendous asset . . . But—and let us be candid among ourselves as well as with the non-profit groups—they must operate within clearly defined systems of constraints. We must find a more effective way for the Defense scientists and engineers to participate more actively in directing the effort of the non-profit groups as well as the work of the industrial laboratories.

"This implies that we recognize a large responsibility for the Defense Laboratories—even larger for the *existence* of the non-profit laboratories."

The Air Force in a recent policy statement said it wants to preserve the "elite nature" of its five non-profit technical advisory corporations. But it conceded precautions are needed to guard against conflict of interest and in holding the salary line.

• **McNamara's "principles"**—In ordering Brown to strengthen the in-house labs, McNamara told him to observe these "principles":

—"The in-house laboratories shall be used as a primary means of carrying out Defense Department programs. They shall provide scientific and technical advice in the exercise of Government responsibility for development and acquisition of new weapons.

—"Clear lines of technical management and responsibility shall be established for each in-house laboratory. To this end, the policies and practices on rotation of duty for officer-scientists will be such as to permit extended tours of duty in positions for which they have demonstrated technical proficiency. In addition, procedures will be established by which the principal laboratories of each service will be brought under the more effective control of the assistant secretaries for research and development of each of the military departments.

—"Depending upon the mission and nature of the work of the particular laboratory, a fraction of the annual laboratory budget shall be set aside for work judged by the laboratory director to be of promise or importance without need of prior approval or review at higher levels. The results of this work shall be reviewed by the assistant secretaries for research and development of the military departments.

—"Full and complete advantage shall be taken of the existing PL-313 provisions which set compensation rates for senior technical personnel in the Defense laboratories. This specifically includes recognition of outstanding performance by the working scientists and engineers who are not in administrative positions.

—"Working with other interested Government agencies as appropriate, the Department of Defense will make every effort to secure rates of compensation for its senior personnel which, commensurate with the responsibilities which they exercise and with their professional talents, are consistent with levels set outside as well as inside the Government service."

• **Morale problem**—In his NRL talk, Brown made no bones about the fact that the McNamara memo was directed at curing a "bad" morale problem in in-house labs stemming primarily from poor management.

"In some of the best laboratories," said Brown, "the disillusionment with the Defense Department and the Military Service as managers is approaching the critical state."

The R&E chief said low pay scales (industry salaries may be more than double) for lab directors, lack of recognition of competence in lab personnel, and poor working facilities were contributing to the morale breakdown. Hence, strong medicine is needed, quickly. ⌗

X-15's Broken Window

WINDSHIELD PANEL on X-15 cracked after AF Maj. Robert M. White had completed re-entry maneuver after 215,000-ft. flight Oct. 10. Cause is still being studied.

FMC TRACKED MOBILITY FOR THE PERSHING

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Technical Countdown

ASTRONAUTICS

Dissent Voiced over Exotic Lunar Rovers

Solutions to the problem of developing lunar-roving vehicles lie not so much in exotic types of locomotion as in rational adaptation of conventional vehicles to the environment. This was the conclusion of a paper on "Land Locomotion on the Surface of Planets" presented at the recent New York ARS meeting by M. G. Bekker of GM's Defense Systems Div. Giving the lie to the clamor about exotic lunar vehicles, Bekker asserts that locomotion on a planet will evolve from studies of that planet's physical properties and surface geometry.

SUPPORT EQUIPMENT

'Aeropad' Proposed for Space Vehicle Transport

A variation of the water transport concept for large space vehicles has been proposed by Aerojet-General Corp. Called "Aeropad," the system is defined as an integrated transport and launch system for land operation which permits massive loads to be transported over low-soil-bearing land with a minimum of surface improvements. The Aeropad, according to the company, would be supported by fluid pressure from a pump source piped between the pad bottom and a prepared surface such as asphalt or concrete. Floating a little more than 2 inches above the prepared surface, the system would provide a lifting force of 1000 lbs./sq. ft. over the entire pad surface.

Army Gets New Air Defense System

A helicopter-transportable air defense system for coordinating the fire of *Hawk* and *Nike* batteries, developed by Hughes Aircraft Co., is now in use by the Army. Installed in five or more plastic and aluminum shelters, the system consists of one operations central and four or more coder-decoder units. The system—designated AN/TSQ-38—enables a battalion commander to assign targets, monitor the air battle, and quickly determine operational status of his air-defense units.

DRIFT Improves Re-entry Communications

DRIFT (Diversity Receiving Instrumentation for Telemetry), developed by Lockheed-California Co. for the *Polaris* program, is reported to have reduced the communications blackout experienced by re-entering vehicles from 20-30 seconds down to zero, in some cases, or at most 9 seconds. The company claims that by using microwave frequencies at about 5000 mc. in conjunction with a new parametric amplifier it has increased sensitivity of telemetry receivers to more than 100 times that of current equipment.

PROPULSION

EBW Introduced Into the Saturn System

Exploding bridgewire circuits are replacing the standard ordnance items used as initiators on the *Saturn* booster, according to one Marshall Space Flight Center official. Citing the relative insensitivity of EBW circuits to temperature and shock, he stressed the safety afforded to personnel due to the great amount of current required over a very short time period—of the order of 500 amperes over 1 microsecond—before EBW will operate.

ADVANCED MATERIALS

Ceramic Tooling & Titanium

Lockheed is taking another look at titanium—this time with ceramic forming tools in mind. The metal easily can be hot-formed with imbedded element ceramic dies. Glasrock Products, Inc., manufacturers of ceramic tooling materials, has been experimenting with Teflon-coated, self-heated ceramic dies for plastic applications.

Ductile Tungsten Obtained

Westinghouse researchers have produced single crystals of tungsten 10 in. long and 0.2 in. wide with purities up to 99.9975%. The ultra-pure crystals are ductile—even at temperatures down to −330°F. Specially designed electron-beam zone-melting equipment is used to produce the commercially available crystals.

World's Largest Arc Heater for NASA

An arc heater capable of supplying a 10-minute stream of high-pressure air reaching temperatures of 12,000°F is being built for NASA's Langley Research Center, Va., by Westinghouse Electric. The heater and its d-c power supply will cost slightly more than $1 million, W.E. says.

ASW & SEABORNE SYSTEMS

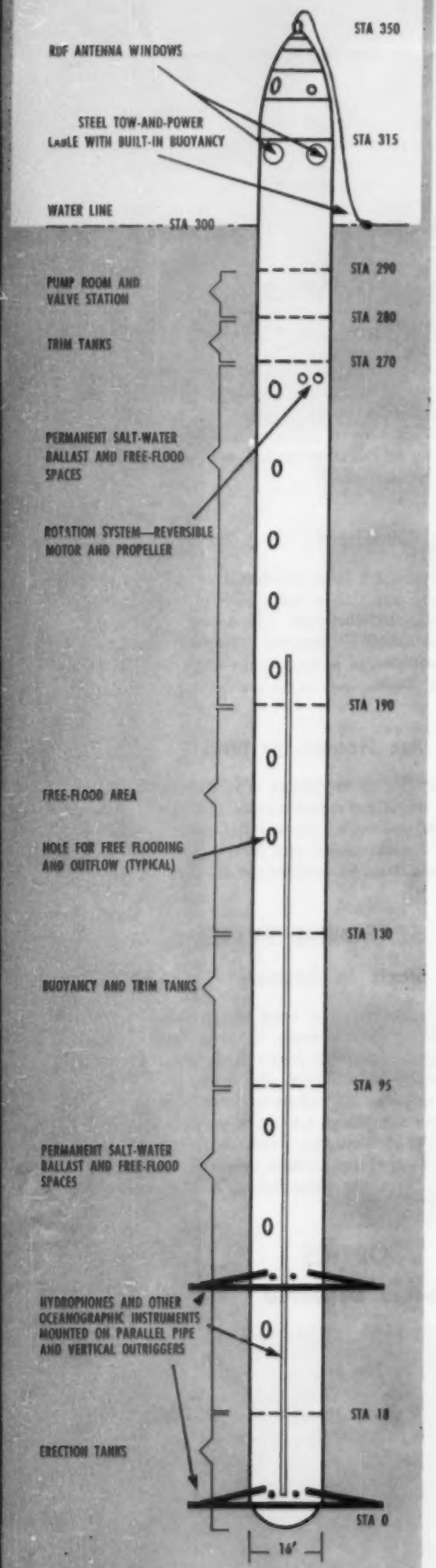
Antarctic Study Starts in January

Texas Instruments Inc. has just been selected to provide an operating and maintenance team to man the USNS Eltanin, Antarctic oceanographic research vessel. Funded by the National Science Foundation, the broad study program will begin in January. The effort will not only include marine and geological samplings for on-board analysis and underwater photographic studies, but will encompass meteorological and upper-atmosphere physical research. Total outlay to date, says the Foundation, is $5.5 million.

OPTICS

Pershing Theodolites Delivered

First portable theodolites offering accuracies comparable to conventional fixed-site instruments are now being delivered for use with the Army's *Pershing* missile system. Built by Perkin-Elmer for The Martin Co., the units employ north-seeking gyros to establish and correct missile azimuth heading in the shortest possible time, developers say. Outputs are fed directly to a computer in the firing set for missile erection and launch.



ASW engineering

SPAR Heralds New Era

Navy's million-dollar tube will be used for unmanned acoustic research; more stable than submarine, 350-ft. vessel will operate with 86% of its length submerged

THE NAVY is planning to build and send to sea for acoustics research a $1-million tube of scientific devices.

Called SPAR—for Seagoing Platform for Acoustic Research—the vessel is a companion piece to FLIP (Floating Instrument Platform) also being developed by the Navy (M/R, July 3, p. 37).

Both vessels presage a new look in oceanographic instrumentation — the first in many years. And the imagination used in devising such vessels means that more money is becoming available for a refined attack on the problems of understanding the ocean.

It also means that the Navy realizes that only through basic oceanographic research can it hope to get a lead on the nuclear-submarine detection problem.

• **More money**—The current program level of $97.5 million for oceanography is an increase of $44.5 million or about 81% over fiscal year 1961 (M/R, Aug. 28, p. 22).

This build-up is part of the national effort in oceanography proclaimed by President Kennedy in his inaugural speech and detailed in his message to Congress on March 29.

The Navy's contribution to the national oceanographic program is $32 million for the present fiscal year; its total budget including military oceanography is $54 million plus a supplemental add-on.

• **Stable platform needed**—The Naval Ordnance Laboratory is developing SPAR as a stable platform for mounting oceanographic instruments, chiefly those useful for sonar and acoustic work. Designed to survive in the rough seas of the Atlantic, the vessel will operate tended but unmanned, whereas FLIP will be manned and deployed in calmer waters of the Pacific.

Chief reason for designing SPAR was to get a highly stable ocean platform. Specifications limit the vessel's vertical velocity to less than one fps.

Such stability is needed in order to cut down the noise around a vessel's hydrophones—noise usually brought in by water slap and vibrations that accompany even the quietest craft.

To gain this high stability, SPAR will—like an iceberg—have most of its volume underwater. The vessel will be 350 ft. long, only 50 ft. of which will be above the water line when the craft is operating; diameter will be 16 ft.

It will have 500 tons of steel in its structure and its displacement will be equal to that of a World War II submarine. In fact, an early idea was to make a stable platform out of a sub by flooding one end until the vessel turned vertical. The venture was soon discarded as being too costly.

SPAR is towed in a horizontal position by a tender at a maximum speed of six knots to its ocean site. Here, the research vessel's compartments are flooded until the craft swings into a vertical position. A 2000-ft.-long umbilical cord carries control data and power to SPAR during its research operations.

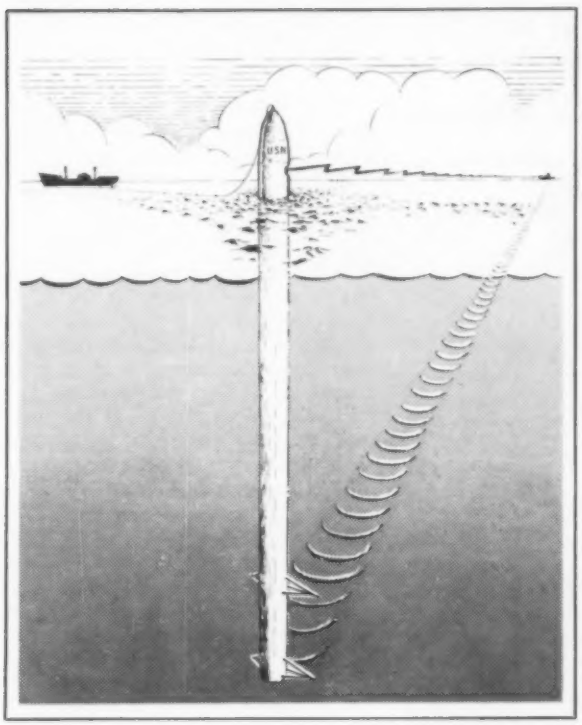
SPAR is turned on its longitudinal axis by a submerged propeller until the vessel's hydrophones are pointing at a participating research ship that may be 50 to 75 miles off. Then, by an interchange of acoustic and electromagnetic signals between SPAR and the research ship, scientists get data on how acoustic energy travels through water; and on the effects of temperature, pressure and salinity on the sound vectors.

When SPAR's work is done, compressed air forces water out of a tank at the vessel's lowermost end, thereby giving the tube the initial turning moment needed to begin an outflow from the upper free-flood tanks.

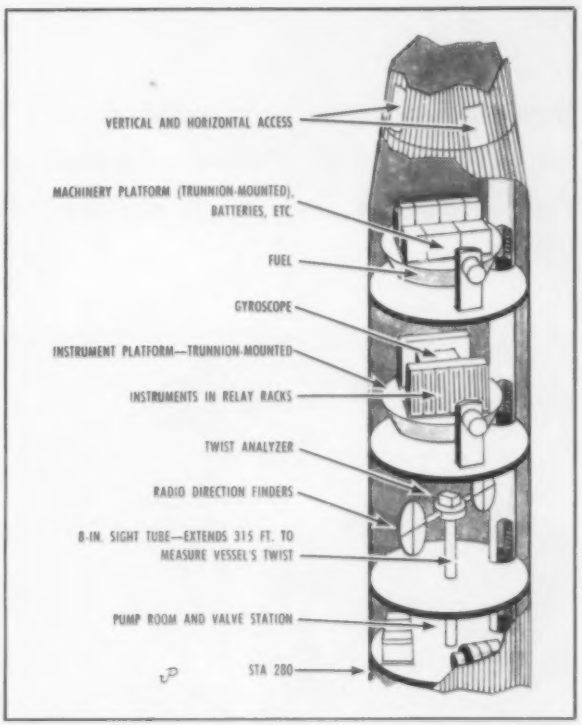
• **It's very quiet**—According to engineering plans drawn for NOL, the

in Oceanographic Instrumentation

by William Beller



SONAR AND ELECTROMAGNETIC signals from research ship form part of SPAR's data collection. Tender is seen at left.



SPAR'S UPPER 70 FEET are given over to instruments and machinery, some of which are kept vertical by trunnion mounts.

upper 70 ft. of SPAR is given over to radio direction-finding antennas, trunnion-mounted panels, trunnion-mounted machinery platform and fuel storage, and a pump room and valve station. Men can crawl into access panels on SPAR's nose to service the vessel even when it is in a vertical position.

Two outriggers near the vessel's bottom and an exterior pipe running along about half the vessel's length are used for mounting hydrophones and other scientific equipment. Although the instruments are subject to some wave slap and eddies, the noise is far smaller than oceanographers are accustomed to hearing through their hydrophones.

Contract plans for SPAR's design were prepared under the technical direction of NOL's Air and Surface Mechanical Engineering department by M. Rosenblatt and Sons, Inc., naval architects and marine engineers of New York. The San Francisco branch of this firm drew up the plans for FLIP.

The big difference between these two projects is that SPAR is unmanned. As a result, all research on the vessel has to be done by remote control or automatically, which just about doubles the cost compared with the manned version.

When larger SPARS are made, thereby rendering them habitable in the Atlantic seas, some of the automation can be removed. Project engineers estimate that after the go-ahead it would take five to six months to build the present SPAR configuration. Right now, the project is under design review by the Bureau of Ships.

The Marine Physical Laboratory of Scripps Institution of Oceanography and NOL started last year to devise stable oceanographic platforms; more or less independently, they arrived at similar solutions.

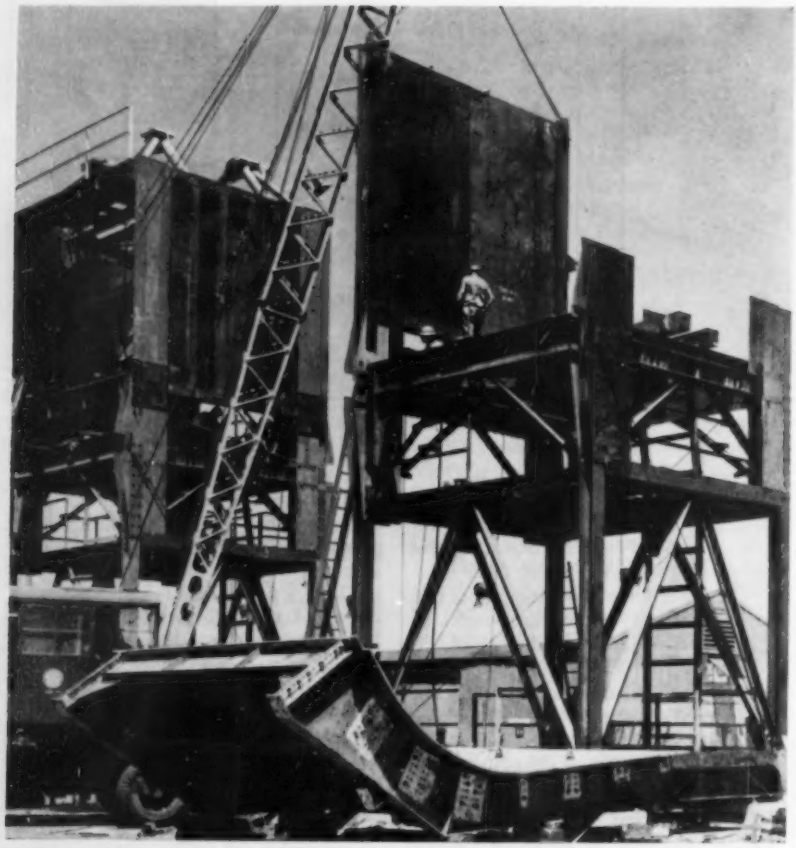
MPL's first thought—after the Navy discarded the submarine idea—was to lower a telescoped instrument tube from a barge to a great depth; or swing a long hinged-truss from the barge into the sea. Unhappily, barges do not have the needed stability.

NOL also considered using combinations of barges, floats and trusses—but again the need for high stability ruled the designs out.

FLIP, which is a modified tube 165 ft. long, will be used for a wide variety of oceanographic work, including biological sampling. On the other hand, SPAR is designed for the vital Navy function of gathering data for basic acoustic research. ⁂

Atlas F's Getting Huge Platforms

Seventy-five-ton launch structures will have tolerances as close as 1/8 in., double as elevators for missiles at hardened Atlas sites in six scattered SAC installations



A HUGE STEEL PLATE—part of the blast deflector for the 75-ton Atlas F launcher platform—is shown being gently lowered into place. Being built to extremely close tolerances, the platform will be installed at six hardened missile bases in the Midwest, Southwest and Eastern U.S.

LAUNCHER platforms weighing close to 75 tons each and assembled with horizontal tolerances of 1/16 in. are being fabricated for six *Atlas F* hardened sites.

Approximately 45 ft. high, the prefabricated steel structures are test-erected at U.S. Steel Consolidated Western Steel Division plant at Maywood, Calif., before being dismantled and shipped to the *Atlas* sites. This is to insure that the extremely close tolerances—⅛ in. from the top of the four steel pads to the bottom of the structure's base plates as well as the horizontal limit—have been achieved.

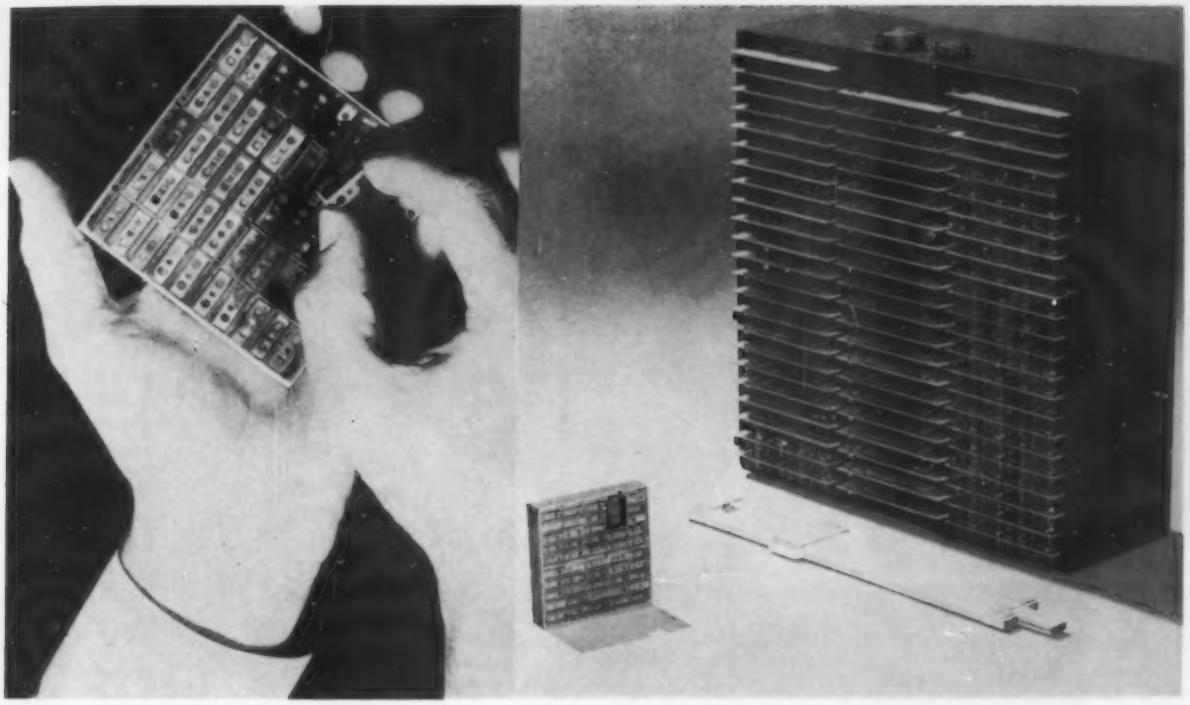
• **Structure's dual role**—In addition to being a launch platform for the *Atlas*, the structure serves as an elevator to lower the missile into the silo for vertical storage. And when the missile is ready for firing, it raises it until the blast deflector on the platform clears the mouth of the silo.

At the top of the four-level launching platform are two tripods which mount four steel pads to support the missile. Immediately below the heavy-walled tripods is the blast deflector—fabricated from 1-in. USS "T-1" steel. The T-1 steel was chosen, according to Western officials, because of its exceptional resistance to the flame and blast effects of a missile launch.

Consolidated Western is also building maintenance paltforms, a ventilation system and other handling and servicing equipment for the underground sites.

The launcher platforms — designed by American Machine & Foundry Co. from Consolidated Western's detailed drawings—are being built under contract to the Astronautics Div. of General Dynamics.

After the platforms have been fabricated and test-erected, they will be shipped to the *Atlas "F"* sites at Schilling AFB, Kan.; Lincoln AFB, Neb.; Altus AFB, Okla.; Dyess AFB, Tex.; Walker AFB, N.M., and Plattsburgh AFB, N.Y. ⌗



MICROMINIATURIZED DIGITAL computer composed of 587 separate Solid Circuit wafers performs same functions as conventional transistorized unit (right) which is 48 times heavier and 150 times larger. Ten-ounce unit (center and left), using 47 modules plugged into a computer matrix, was developed by Texas Instruments Inc. for the Air Force.

electronics

Solid-State Circuitry Computer Shown

Texas Instruments builds 10-oz. digital unit which matches functions of device 150 times its volume

by Charles D. LaFond

DAYTON, OHIO—A way of using completely microminiaturized solid-state circuitry in a practical system was demonstrated for the first time last week.

With tiny silicon-wafer digital networks connected and encapsulated to form rigid modules, engineers built a 10-ounce digital computer which can perform all the functions of a conventional transistorized computer 48 times heavier in weight and 150 times larger in volume.

Culminating two years of research in the development of microelectronic circuits, Texas Instruments Incorporated also announced the commercial availability of a whole series of Solid-Circuit semiconductor networks. Known as the Series 51 line, the new components include six different digital circuit modules.

Ninety percent of all digital equipment circuit functions can be handled by these six devices, according to TI President P. E. Haggerty.

Employed in the experimental computer which was demonstrated, the semiconductor networks accounted for 95% of the total circuitry. The whole unit occupies only 6.3 cu. in.

The computer was built for the Air Force to forcefully demonstrate the results to date of this part of its Molecular Electronic Program. It was developed, assembled, and successfully tested by TI in 9 months, an AF spokesman said.

• **Solid Circuit networks**—Each network in the TI Series 51 is contained in a hermetically sealed outer case measuring ¼ x ⅛ x 1/32 in., excluding leads. Total volume of each is about 0.001 cu. in. A comparable circuit using conventional semiconductors and other components would require nearly 1 cu. in. total volume.

The first solid circuit developed by TI was shown to the Air Force in October, 1958, and revealed publicly at the 1959 Annual Institute of Radio Engineers Conference in New York City. Early in 1960, units were made available for industry evaluation in sample lots.

The Series 51 line now obtainable in quantity is an improved version of the earlier networks, TI says, with advances made in circuit design, miniaturization, and fabrication techniques.

Relatively few process steps are now necessary in production of the devices. This permits a high degree of control and further enhances reliability, TI says. All units in the series are built up from a very-pure standard silicon wafer. Electrical paths are cut in the slices or wafers; then appropriate connections are made to create six different circuit functions.

Circuits are protected with an oxide coating and the leads for point-to-point

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Fixed base—AMF's experience in designing automatic machinery was utilized in the 10,000-lb. AN/FPS-19, the famous "Dew Line" antenna, designed and built by AMF to operate unfailingly under fantastic arctic conditions.

Mobile—AMF designed and built AN/TPQ-10 precision tracking antenna that demounts into shock-resistant, immersible components. AN/MPS-4 and 16 are AMF-designed trailer and truck-mounted types.

Stabilized base—Design and fabrication of SX, AN/SPS-8B High Gain Antenna, AN/SPS-3 Dual Foster Scanner.

Precision pedestals, theodolites—AMF's Precision Instrument Mount is controlled by optical digital discs accurate to 0.05 milliradans. It tracks missiles and satellites.

Rotary joints—A special AMF capability requiring utmost precision in design. Example: multichannel joint for AN/FPS-24 System.

Scanners, Feeds, Servos and *Drives*, Multichannel Phase Shifters, Hydrostatic Bearings, Slip Rings, Programming, Test, Control and Display systems are all part of AMF's radar capabilities. AMF also operates its own test ranges.

For more information, write American Machine & Foundry Company, Government Products Group, 261 Madison Avenue, New York 16, N.Y.

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connections on the silicon bar are vapor-deposited.

The new devices consist of

—A flip-flop/counter circuit (SN 510).

—A flip-flop/counter circuit with emitter follower output (SN 511).

—A NOR/NAND gate (SN 512).

—A NOR/NAND gate with emitter follower output (SN 513).

—Two NOR/NAND gates in a single package (SN 514).

—An exclusive OR gate (SN 515).

Designed for operation in a temperature range from −55°C to 125°C, the units have a power drain of from 2 to 4 milliwatts at 3 volts. Supply voltage requirements are from 3 to 6 v. Propagation delay is from 75 to 450 nanoseconds.

Unit prices, Haggerty says, will range from $95-115. Thousand-unit lots will be priced at rates down to $50-65 per unit. Quantity prices, he said, make the units competitive with semiconductor-type circuit boards providing equivalent functions—when labor costs are considered in system applications.

He predicted that costs will be directly competitive with military-quality circuit boards by 1963, with industrial types by 1966-67, and with consumer quality items in 10-12 years.

Carrying his forecasts even further, Haggerty told M/R that he believes over half of TI's semiconductor component revenues will be derived from Solid Circuit sales in 10 years. He does not, however, believe that the new field will cut into conventional semiconductor sales by 50%; rather, he sees it finding new applications and growing with its associated industry.

The company said that although units are now available, tests will be continued to determine high-temperature storage and operating-life limits. Additional ambient temperature and other environmental tests also are being conducted as part of TI's continuing reliability studies.

• **Minified computer**—A multitude of the tiny Solid Circuits have been used by TI to build its new digital computer. The complete package is made up of 47 modules. Each module contains from 8-16 of the thin semiconductor networks.

Individual networks perform the function of from 10-29 conventional miniature or solid-state components. Each module performs the work of some 150 individual components.

The complete unit, according to TI, is composed of 587 separate Solid Circuits—equivalent to roughly 8500 conventional components.

The 47 modules employed are plugged into a computer matrix. Each module contains an average of 12 networks, occupies roughly 0.057 cu. in. and weighs about 0.04 oz.

The finished package is a serial, binary, fixed-point computer having an operand word length of 10 bits, plus sign. Using synchronous logic, the system is timed from an internal 100-kc clock.

Memory is divided into two parts, operand and instruction. The complete unit is actually a general-purpose computer.

Three types of Solid Circuits were used in the design of the system: RS flip-flops, NOR gates, and logic drivers.

Power dissipation of the unit is only 16 watts.

Indicative of the problems of fabrication in dealing with such small parts, TI engineers said that although special tools were not necessary a 10-power microscope was employed for all assembly work.

During assembly each network is held in a jig while interconnecting strip conductors are welded to various leads. Stacks, when assembled, are next encapsuled.

• **Future applications**—Some of the immediate results of the company's work already can be visualized, Haggerty pointed out. For example, it will be possible to build a guidance computer designed for use in an air-to-ground guided missile which will weigh only 5 lbs. and occupy about 50 cu. in. Its counterpart using conventional components and design would need a total volume of 3330 cu. in. and would weigh 115 lbs.

Solid Circuits, Haggerty said, would satisfy over 95% of the circuit functions of such a system.

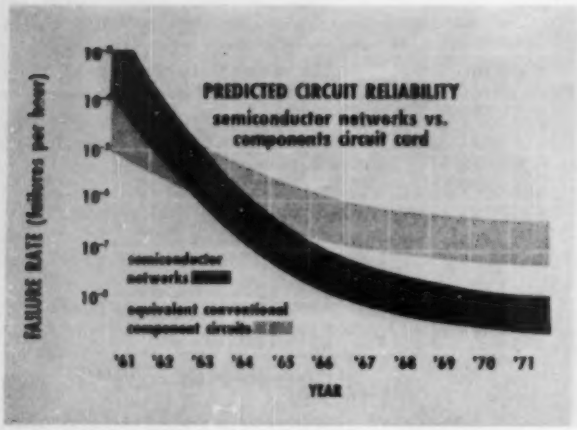
Obviously the savings of 110 lbs. could be reflected either in a sizable increase in missile range or in much heavier payloads.

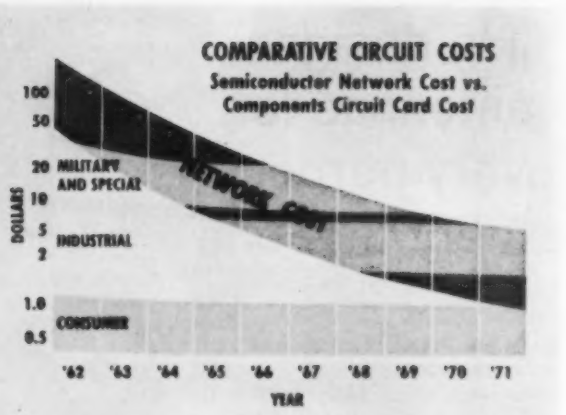
A typical missile programer today, weighing over 7 lbs. and using 220 cu. in., could be reduced with the new components and techniques to a volume of only 15 cu. in. It would weigh about 1½ lbs.

For the future, TI is developing a new Series 52 for linear functions. These new networks, according to Haggerty, will include a low-level audio amplifier, an operational amplifier, a d-c differential amplifier, a video amplifier and a power amplifier (1-3 watts).

An immediate application for these new items would, of course, be in missile-borne telemetry. As an example of size advantages, Haggerty compared a conventional PCM telemetry encoder with a microminiaturized version now being developed: size will drop from 1680 cu. in. to 30; weight from 50 lbs. to 3.

Like the digital computer, the en-


PREDICTED CIRCUIT RELIABILITY
semiconductor networks vs.
components circuit card
FAILURE RATE (failures per hour)
semiconductor networks
equivalent conventional component circuits
'61 '62 '63 '64 '65 '66 '67 '68 '69 '70 '71
YEAR



RELIABILITY AND COST predictions by Texas Instruments President P. E. Haggerty are described in curves above, comparing semiconductor networks with circuit boards as envisioned during the coming decade.

coder is being developed for the Electronics Technology Laboratory of the Air Force's Aeronautical Systems Division, at Wright-Patterson AFB, Ohio.

The new system, Haggerty stressed, will equal conventional units in performance and will handle both digital and analog functions. These include some analog circuit functions calling for system accuracies of 0.1%.

• **Future industry impact**—All who have followed the progress of microminiaturization, solid-state functional subsystems, molecular electronics (or whatever other name comes to mind) have known intuitively that savings in weight, size, reliability—and possibly cost—would someday result from this intensive national effort.

TI has performed a series of studies to determine the future impact of such systems on the future of electronics. To illustrate, Haggerty pointed out that of the 155,000 electronics engineers and scientists now employed throughout the nation, 120,000 are involved in government work.

This figure represents a limit of sorts—and time will not increase it sufficiently to meet the ever-increasing demand in the industry.

Total expenditures, he said, were roughly $6.5 billion in 1960 for government—or so-called "military"—electronics. Thus, by simple division, total expenditure per engineer or scientist works out to be $54,000 per year.

He then pointed out that average cost for each of these persons, including overhead, is roughly $25,000 per year. Hence, only a little more than half the total expenditure of $54,000 actually goes for the production of the final pieces of hardware.

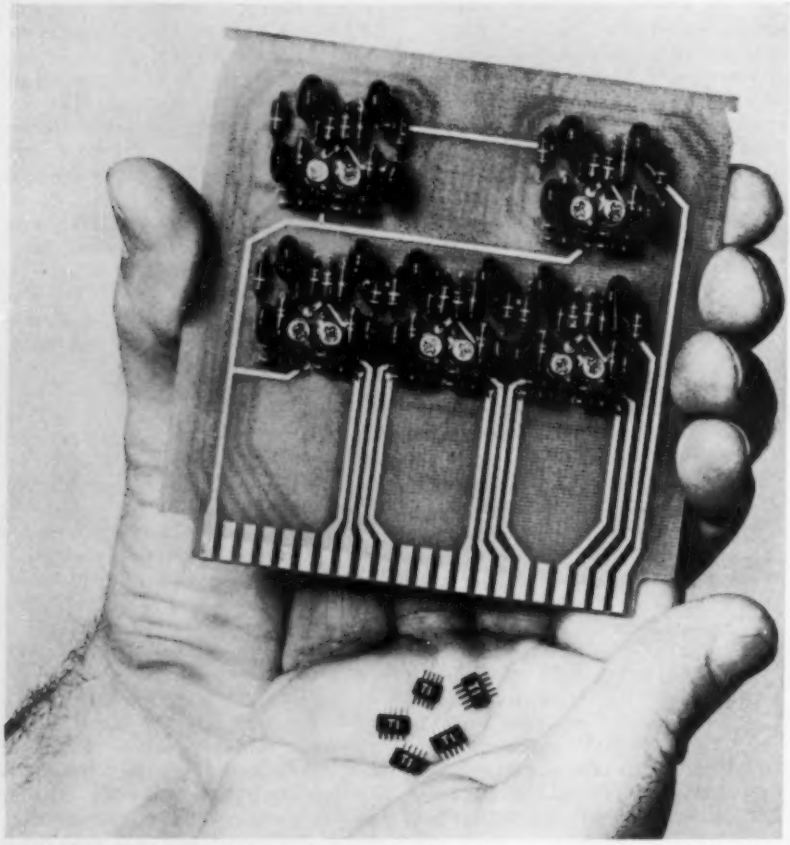
Therefore, said Haggerty, it appears that we must free these technical people from some of their present work to better utilize their efforts. Molecular electronics shows promise of doing just this.

With semiconductor networks, considerably fewer processes are required for production of both the networks themselves and the systems in which they are used.

TI studies, he asserted, have shown that with a few hundred standard semiconductor networks, performing digital and analog functions, some 10% of today's specialists could be freed to tackle tasks other than just hardware development and production.

The savings in money would be about $300 million.

Haggerty emphasized that there is also a hidden savings: semiconductor networks are inherently more reliable than equivalent circuits using conventional parts. ⠿



FIVE SEMICONDUCTOR networks functionally replace the entire conventional etched-card circuitry shown above. The new units are expected to be competitive with circuit boards of military quality by 1963, developers say.

Data System to Sharpen Nike-Zeus

Radiation Inc.-developed digital processor will be set up at test sites to tie radars to computer

by James Trainor

A DIGITAL data system designed to provide a vital link between the missile tracking radars and the target intercept computer is being added to the *Nike-Zeus* ground equipment and promises to increase the overall effectiveness of the Army's antimissile missile.

Called a "Tape and Buffer System," the data processor has already been installed at Bell Telephone Laboratories' Whippany, N.J., location and is to be delivered to *Zeus* test sites at Ascension Island, White Sands Missile Range and Kwajalein Island.

In addition, Radiation Inc.—designer and developer of the system—has been awarded a contract for development of a similar system for use in an experimental prototype of the *Nike-Zeus* Defense Center.

• **Designed for flexibility**—The tape and buffer system receives information from the Target Track Radar (TTR), records this information in "real time" on magnetic tape and then translates it into the format required for analysis by the guidance computer—an IBM 704. The system also can translate the computer outputs into suitable form for entry into the TTR.

For testing purposes, the system simulates inputs to the TTR and allows data to flow in either direction from a typewriter or punched paper tape. Finally, the system is able to read out data on an electric typewriter or punched paper tape and, utilizing the typewriter for data inputs, provides for system self-checking.

Using both real and simulated targets for system, or TTR tests, the tape and buffer units will record the essential data including:

—Encoded antenna shaft angles.

—Angular errors in tracking.

—Range and range rate as measured by digital range units.

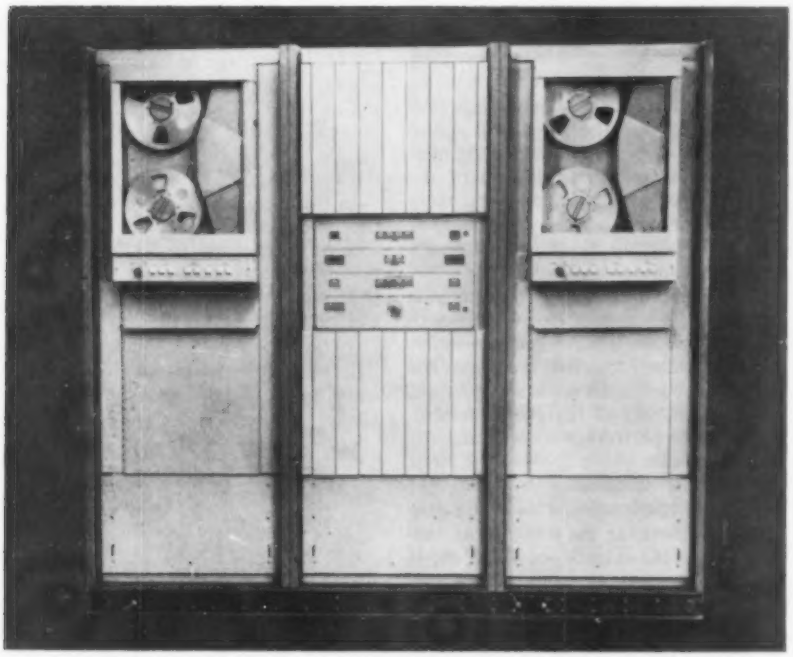
—Variations in the gain of the IF amplifiers controlled by a digital automatic gain control loop.

The recorded data is then analyzed to determine the performance of the antenna servo loops, to determine the angle and range tracking accuracy and to evaluate the gain control loops. During simulated engagements, the system not only records the response of the radar and its tracking effectiveness but also supplies the target data to the radar for the simulated target.

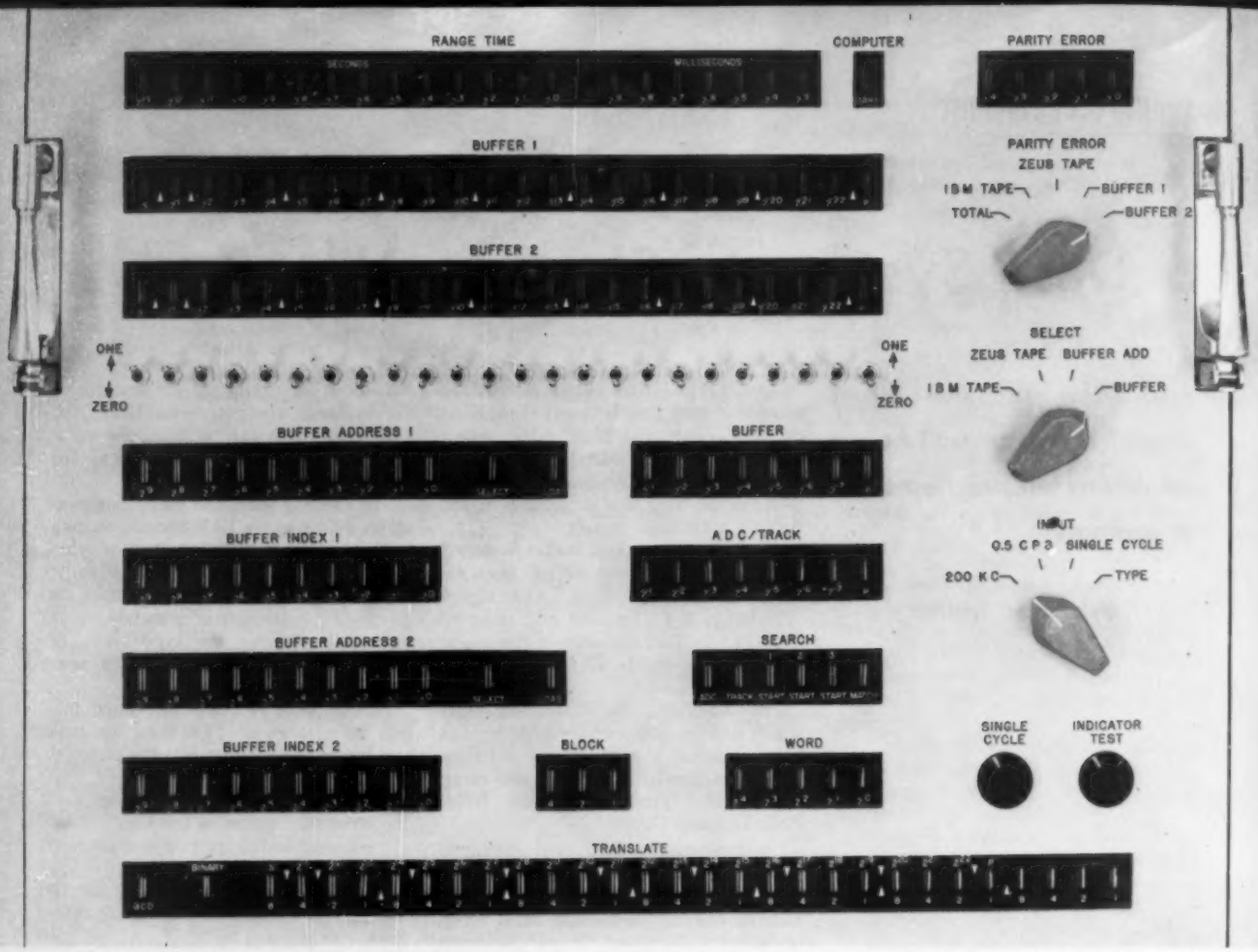
• **Components and packaging**—The equipment used in the Radiation system permits real time recording of a large amount of radar data without imposing a limitation on the frequency spectrum received.

To achieve this the tape and buffer system was designed to include electronic logic, programing controls, operating controls and a power system. It also utilizes two Ampex 400 Digital Tape Handlers, an IBM Model 82 Input-Output Writer, a Soroban paper tape punch and reader unit and a Telemeter Magnetics Inc. magnetic core memory unit.

These components are mounted in three cabinets designed and constructed by the Western Electric Co. Modular units containing the system's logic are mounted on slide-out panels to ease maintenance and to facilitate future system expansion.



DIGITAL DATA SYSTEM being integrated into the Nike-Zeus system to provide information from the Target Track Radar in the proper format for computer analysis. The systems were designed and developed by Radiation Inc.



CLOSEUP OF CONTROL PANEL for digital system illustrates flexibility. It can be used not only to process information from the TTR but also to simulate data for systems tests and diagnose malfunctions in TTR and computer.

Using digital tape handlers to generate tape gaps and system operating controls for high-speed cycling, the digital system records data in blocks on the magnetic tape. The tape speed in all modes of operation is 75 in. per sec.

Using the typewriter system, it is possible to enter data or read it out of the TTR data processor in several forms —alpha-numeric, octal, binary or binary-coded decimal.

• **System operation**—The tape and buffer system receives the words necessary to make up one record in parallel form from an output register of the TTR data processor. After "buffering" in the magnetic co-incident current type memory, the records are written in the *Nike-Zeus* "format" on a seven-channel magnetic tape using the non-return-to-zero method.

Once translated into the *Zeus* format, the tape can be converted by the tape and buffer system into the word format required by the computer. This converted data is recorded on a second magnetic tape and can be transferred to a magnetic tape reader for analysis by the computer without any special input routine. The two remaining operating modes—computer-to-typewriter and tape-to-typewriter—enable the computer to check the various TTR components.

By using specially prepared tape, the system can simulate the digital inputs to the *Nike-Zeus* TTR data computer. The tape is transferred to one of the tape transports in the system and there translated into the *Zeus* format and fed into the TTR data computer—thus supplying the simulated inputs.

By combining the two preceding operations, it is possible to evaluate both the TTR and, on a very rapid time-sharing basis, the computer reaction. The latter can be written on a second tape. Thus an analysis of the guidance computer can be performed without actually firing a missile.

The system operator by using the typewriter can formulate data in alpha-numeric, numeric or octal form and enter this data directly or from paper tape into the computer. Since the system contains a binary-coded decimal-to-binary translator, it allows the operator to enter typed numbers in the binary format normally required by the computer. For data analysis the typewriter will print out information in alpha-numeric, binary or octal form.

One advantage of having a selection of output modes is for diagnostic checking of the TTR components. If a component is faulty in the radar, it is desirable to print out the information on the malfunction in the most useful form —in this case, alpha-numeric form. On the other hand if the tape and buffer unit or the computer malfunction, the binary or octal modes are more useful in that contents or registers or tape data can be displayed bit by bit.

The binary coded decimal is essential for operations at Ascension Island since the input data arrives in that form. Binary and octal codes are included for checking purposes so that an operator can supply input data or insert numbers into the tape-buffer system or the computer.

In overall operation, the tape and buffer system provides a real time means for digesting large quantities of information gathered by the Target Tracking Radar. And, by translating this data into suitable form for the guidance computer, it increases the effectiveness of the total *Nike-Zeus* system. ⌘

Integrated Microcircuitry Matures

Vacuum Society meeting in Washington told that deposition technique is adequate; tolerances tough

by John F. Judge

BY 1963, evaporated, integrated microcircuitry will be manufactured in production quantities more cheaply than printed board circuits are produced today.

D. W. Moore, manager of Solid State Physics at Lear, Inc., told members of the American Vacuum Society at their 8th National Symposium that integrated microcircuitry is about to enter its adolescence—if not full maturity.

"The absolute necessity to enable it to do this is the ability of firms producing this type of circuitry to be able to deposit the active and passive components so that the desired system accuracy is consistently and reliably obtained," Moore says. "This can be done with current techniques conventionally utilized.'

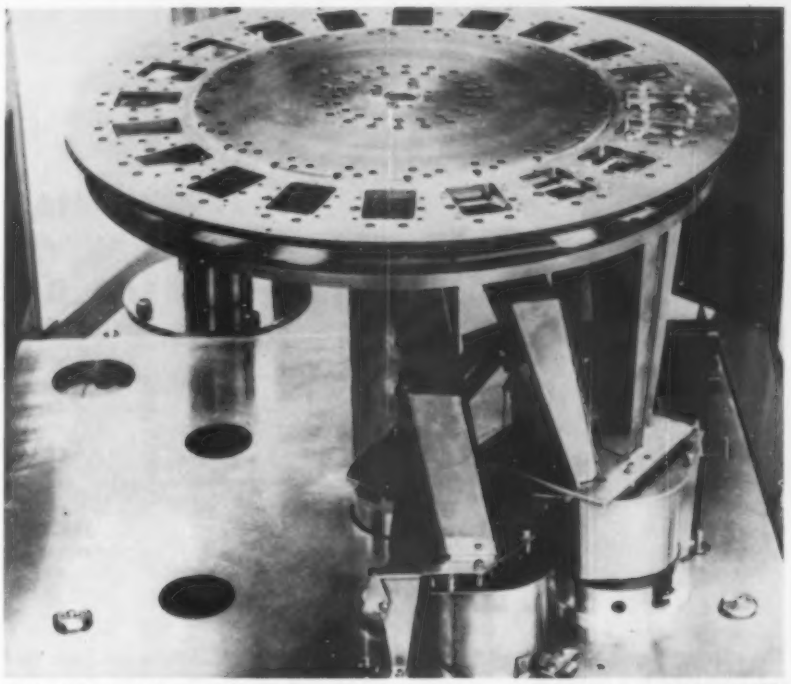
By current techniques, the Lear physicist means the thin-film deposition of miniaturized counterparts of electronic components used in conventional circuitry. Moore says microcircuitry for electronic systems is an entirely different problem from microcircuitry for demonstration or advertising purposes. System microcircuitry must perform a specific function, reliably and well—for a reasonable price.

It must be capable of exactly duplicating a conventional circuit if it is replacing an existing one which functions cooperatively with other mechanical and/or electrical equipment.

If the system is a new one, it must be possible to handle the microcircuitry in a manner of analysis which is familiar to electronic engineers and can be duplicated with reliable hardware.

• **Tolerances tricky** — The biggest problem facing the microcircuitry engineer is that of reproducing the circuit to the required operational tolerances. For example, says Moore, in a resistor pattern for an individual amplifier having 8 resistors, all 8 are deposited at one time and all are within the required tolerance of ± 5%.

When a pattern of this type is deposited it is imperative that the resistors be in tolerance after evaporation and that no hand tailoring or adjusting is necessary. In cases involving unusually accurate resistors, hand work may be needed. But for conventional tolerance such work renders the fabrication costs prohibitive.



SIMULTANEOUS DEPOSITION of twenty separate integrated microcircuits is possible with substrate and mask holders such as this unit.

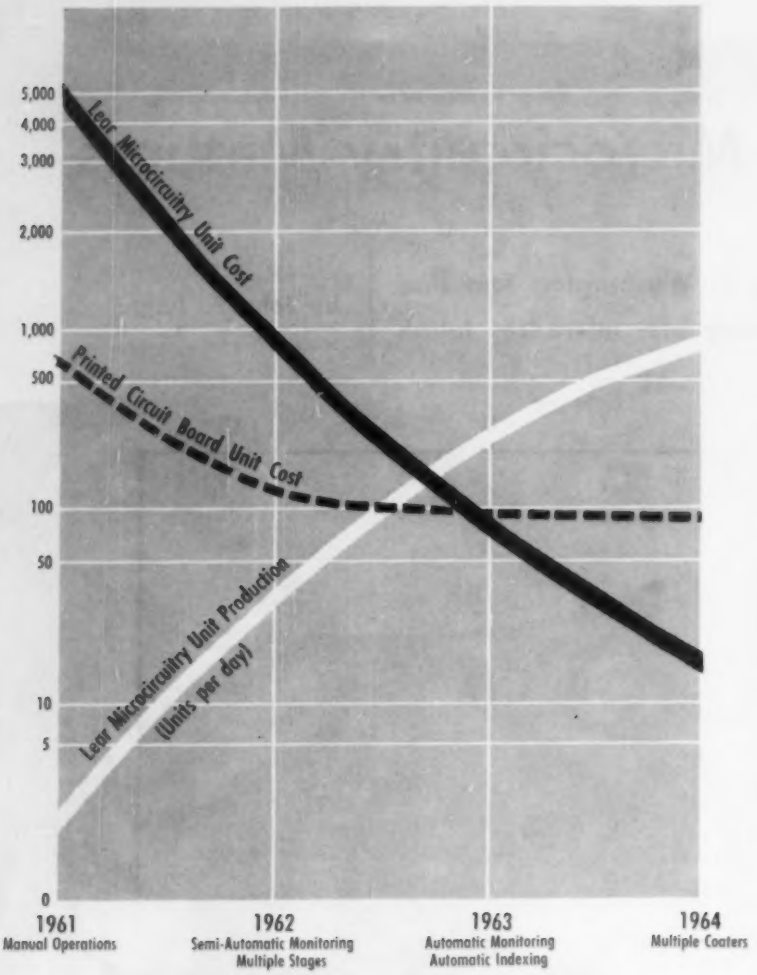
In designing thin film resistors, Moore prefers low-ohm-per-square films from the standpoint of reliability and stability. This approach means more careful masking in the depositions process.

• **Thick vs. thin**—In evaporating a resistance pattern, accurate knowledge and control of the deposition of the resistance material is a necessity. This includes knowing the change in resistance of stablization curve of a resistor or resistor pattern after evaporation is complete.

An evaporated resistance film is initially deposited in an amorphous condition, says Moore. It must then crystallize—which changes its resistance somewhat. When the film is exposed to air, surface oxidation further affects the resistance.

Thin-film resistors should be deposited upon substrates sufficiently hot so that the mobility of the film will permit rapid crystallization. This crystallization must be complete before removal from the vacuum chamber or it will occur over a period of months, resulting in an unstable component.

If the film is too thin, atmospheric exposure will result in unpredictable resistance changes. Low-ohm-per-square films are considerably thicker than high-ohm-per-square material, and their surface-to-volume ratios will be higher.



Lear's Microcircuit Cost Projection

The change in resistance caused by surface oxidation is a function of this ratio, and the change in a thick film will be less.

Extremely thin films (less than 500 A) are quite unstable, Moore says, and will change considerably after being delivered to the ultimate user.

This bolsters Moore's argument against high-ohm-per-square material. In depositing an accurate resistance pattern, it is obvious that if 100-ohm-per-square film is used, masks are accurate and adequate monitoring means employed, it is reasonably simple to evaporate an accurate pattern.

But if 2000-ohms-per-square film were used with accurate masking techniques, it still would not be possible to evaporate an accurate resistance pattern because of the high resistance changes due to atmospheric oxidation.

Moore maintains there is only one place where accuracy can be designed into a thin-film circuit—this is in the evaporation mask. Masks for Lear microcircuits are etched in type 300 series stainless steel 0.005 or 0.008 in. thick.

• **Precise processing**—The original circuit layout is done on Ruby Studnite Thin, a commercial stencil-cutting film, 25 times the size of the actual circuit to insure drafting accuracy. All photo reduction is done in two stages, with a Robertson Process camera; all final positives are on DuPont Cronar film.

Openings in the finished masks are often less than 0.005 in. wide. A 5% tolerance on this line width would be 0.00025 in., and all of the resistance tolerances cannot be used in the masking process. Some very careful photography is involved.

In the evaporation process, Lear employs a monitoring resistor. Its resistance is constantly checked; when it reaches a pre-determined level, the evaporation process is halted. This termination can be effected to a very high degree of accuracy, says Moore, by using a digital ohmeter with an automatic cut-off in the fourth digital place.

Lear handles capacitors by evaporating the electrodes and the dielectric material. Silicon monoxide is the dielectric material. The main problem is to so control the process that the deposited film is free of pin holes.

• **Selective penetration**—Moore feels the prime causes of pin holes are mechanical—foreign particles spattering from the evaporation source. The reduction of such spattering is accomplished by sufficient separation between the evaporation source and the substrate.

The "Q" values of these capacitors should run between 100 and 2000. A low value is an indication of incipient or small pin holes. Moore says one way of living with pin holes is to overcoat the silicon monoxide film with a second film of transistor-grade silicon. This will fill the holes in the monoxide and have an electrical resistivity high enough to produce a capacitor with a "Q" sufficient for use in many circuits.

The use of this second film is based on the observed phenomena of dielectrics avoiding pin holes. The hole propagates through multiple layers of the monoxide. The deposition of a second electrode will short out the capacitor because of the ability of the metallic film to enter the hole.

Since the diameter of most pin holes is less than 1 micron, Moore feels he is dealing with an interesting phenomenon—the fact that materials such as dielectrics will avoid the hole while metals will freely enter.

Dielectric films cannot be monitored by resistance measurements; hence Lear experts observe the shifting color fringes due to light interferences as the dielectric film builds up on the sustrate.

Moore and his associates are able to deposit capacitors to within ±5% of the desired value by observing color fringes. The light is inherent in the evaporation process.

Interconnection between the capacitors and resistors in an integrated microcircuit is made by evaporated gold film deposited over a flash film of nichrome or chromium. The flash film provides proper matching between the gold and the glass substrate.

Active components, such as transistors and diodes, are now inserted into the array of evaporated passive components. Uncased types are used to permit as much volume reduction as possible. Insertion is routine and consists of a low-power microscope and a pneumatic micromanipulator.

• **Active element block** — Moore says the urgent requirement in inte-

(Continued on page 49)

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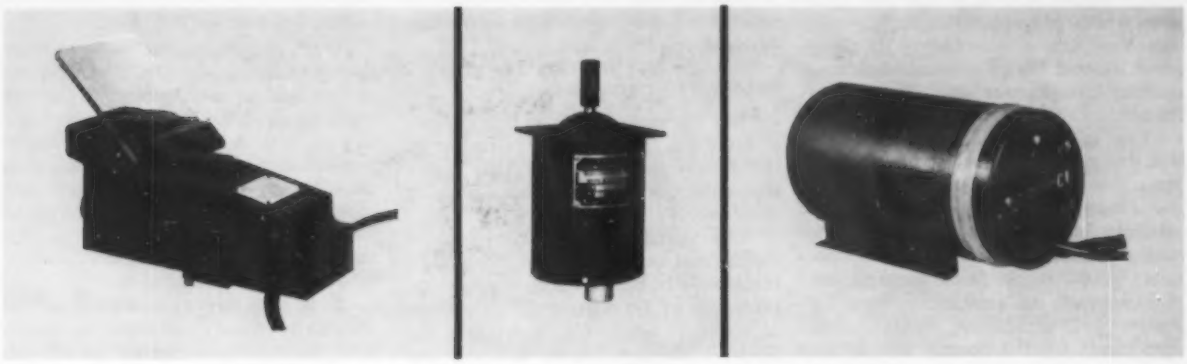


THREE OF THE COTELEC UNITS used to simulate hand-telecontrolled missiles for pilot training are shown above.

by Jean Dansac

Mr. Dansac is an engineer with the Cotelec Co., Boulogne, Seine, France.

PARIS—Development of a simulator is under way to train pilots in the tricky art of shooting hand-telecontrolled air to-air and air-to-ground missiles at the same time they are flying supersonic aircraft.

Hand-telecontrolled missiles, such as those developed by Nord Aviation, are guided from the aircraft through an omnidirectional control stick which will accelerate the missile proportionately to the deviation of the stick and in the same direction as that deviation.

The system being devised for the French Ministry of the Air Force by the Cotelec Co., designated the Simulator-Type 100, allows the pilot trainee to guide a fictitious missile into a target through an optical device. Actually a luminous spot projected to the infinite by the plane's gunsight, the "missile" and its motions are controlled by the simulation set. The functions of this latter device can be summarized as follows:

—Flight programing of the "missile" developed by the programing timing switch.

—Double integration of orders given by the telecontrol stick before transmission to the mobile spot which simulates the missile.

—Simulation of the distance between the missile and the shooting aircraft.

—Stabilization of the fictitious missile by gyros which, through their participation in the computation, make the absolute motions independent of the shooting aircraft's motions about its center of gravity. The gyros also provide a reference for the initial position of the guiding axes.

• **Flexible, versatile system** — Mounted aboard aircraft normally equipped with hand-telecontrolled missiles, the simulator can be adapted to the fire control system without modifying the supports and wiring of the standardized firing elements.

To convert an operation aircraft into a trainer it is only necessary to replace three black boxes of the fire control system with three simulator boxes. This modification can be carried out in less than an hour.

However, since there are several types of hand-telecontrolled missiles, it is necessary to provide the pilot with the closest simulation possible between the spot of light on his gunsight and the actual missile that he carries. These differences between missile types can be compensated for by adjusting the coefficient relating to the load factor of the missile and the initial velocity conditions of the fictitious missile.

Also, in order to transmit to the mobile spot apparent motions independent of the position of the control stick, the luminous spot goes to a point of coordinates, at firing, equal to 75 milliradians in downward elevation and plus or minus 100 milliradians in azimuth—depending on whether the pilot has selected the "right" or "left" missile.

After reaching one of these positions the luminous spot comes back to the aircraft axis with an apparent elevation velocity of 65.5 fps and an azimuth velocity of approximately 197 fps. During the two seconds which follow, the pilot guides the luminous spot with the control stick while constantly maintaining the flight path of his aircraft.

The complete set of simulation operations "between the start of the missile and its coming at the target" is done within about 18 seconds. At the end of the sequence the spot remains motionless for several seconds so that a recording camera can take successive pictures of the missile and the spot. These are later used to evaluate pilot performance.

• **Compact unit**—After the necessary data are recorded, the various devices in the simulator automatically return to "zero" and are ready for another practice shot. The pilot is warned of the successive simulation phases by means of luminous signals transmitted through his gunsight.

The adaptation of this equipment to various aircraft of the French Air Force and Naval Air Force has been made possible to a large extent because of the easy interconnections and small volume of its components. The principal parts of the system, in addition to the gunsight and the control stick, are: the 619-cu.-in., 11.5-lb. Resolver and Power Supply Unit; the 787-cu.-in., 14.5-lb. Computer and Integrator Unit; the 171-cu.-in., 5.5-lb. Programing Unit and the 9.5-lb. Gyro Unit. The system operates on 27 volts DC and 115 v, 400 cycle power.

Although the Cotelec Simulator-Type 100 cannot hope to be 100% effective in training pilots to fire hand-telecontrolled missiles, it does provide an economical, lightweight means of teaching pilots. ■

Gilpatric: Enemy nuclear attack would be 'self-destruction'

(Continued from page 12)

How do we go about the conversion of these vast sums into defense programs to support our national policies?

First of all, in January of this year, the President set in motion a major review of our defense posture and policies which has already brought some significant changes, including the budget increase I have just mentioned; and further changes are still being considered.

One of the President's conclusions was that our arms must be adequate to protect our commitments and ensure our security without being bound by arbitrary budget ceilings. At the same time he envisaged that military economies would result from management improvements in government and industry, and ultimately perhaps from agreements for the control and limitation of arms.

The President was determined that our strategic power must be sufficient to deter any deliberate nuclear attack on this country or its allies by being able to survive the first strike by the enemy with sufficient arms to penetrate his defenses and inflict unacceptable losses upon him.

For 'Lower Level' Attacks

President Kennedy also called for greatly increasing our ability to handle lower levels of conflicts, including local wars and those sub-limited, guerrilla-type struggles which have constituted the most familiar threats to the free world since 1945. He has also determined to improve the flexibility of our defenses, by improving our ability to make swift, selective responses to enemy attacks on the free world regardless of time, place or choice of weapons. At the same time the new Administration embarked upon a political action program designed to reduce the danger of general thermonuclear war due to error or enemy miscalculation or the runaway spread of a smaller conflict.

Thus, while we are making all honorable efforts for a diplomatic solution to the problems of Berlin and Germany, we are intensively studying the organizational and technical aspects of our "command and control" systems to assure a controlled response to any form of aggression.

Berlin is the emergency of the moment, because the Soviets have chosen to make it so. We have responded immediately, with our western allies, by reinforcing our garrisons in that beleaguered city. We have called up some 150,000 reservists, increased our draft calls and extended the time in service of many who are already in uniform. These are the so-called "quick-fix" measures which we have invoked to improve the western tactical position in Berlin and remind the Soviets that the city is not an open invitation to that variety of aggression which has been described as the salami, or one slice at a time, method.

Relative Nuclear Power

But our real strength in Berlin—and at other any point in the perimeter of the free world's defenses that might tempt the Communist probes—is much more broadly based.

Our confidence in our ability to deter Communist action, or resist Communist blackmail, is based upon a sober appreciation of the relative military power of the two sides. We doubt that the Soviet leadership has in fact any less realistic views, although this may not be always apparent from their extravagant claims. While the Soviets use rigid security as a military weapon, their Iron Curtain is not so impenetrable as to force us to accept at face value the Kremlin's boasts.

The fact is that this nation has a nuclear retaliatory force of such lethal power that an enemy move which brought it into play would be an act of self-destruction on his part. The U.S. has today hundreds of manned intercontinental bombers capable of reaching the Soviet Union, including 600 heavy bombers and many more medium bombers equally capable of intercontinental operations because of our highly developed in-flight refueling techniques and world-wide base structure.

The U.S. also has 6 *Polaris* submarines at sea carrying a total of 96 missiles, and dozens of intercontinental ballistic missiles. Our carrier strike forces and land-based theater forces could deliver additional hundreds of megatons. The total number of our nuclear delivery vehicles, tactical as well as strategic is in the tens of thousands; and of course, we have more than one warhead for each vehicle.

Our forces are so deployed and protected that a sneak attack could not effectively disarm us. The destructive power which the United States could bring to bear even after a Soviet surprise attack upon our forces would be as great as—perhaps greater than—the total undamaged force which the enemy can threaten to launch against the United States in a first strike.

In short, we have a second strike capability which is at least as extensive as what the Soviets can deliver by striking first. Therefore, we are confident that the Soviets will not provoke a major nuclear conflict.

It might be appropriate at this point to say a few words about the Soviet's announced intention to explode a 50-megaton thermonuclear device at the end of October.

Our own scientists and military leaders examined the utility of weapons of this and even larger yields several years ago and concluded that the military value was so questionable that it was not worth developing such weapons even though we had the know-how and capacity to do so. While there might be some military advantages from extremely large yields, there are also operational disadvantages.

It is therefore quite clear that the Russian's primary purpose is terror. With the customary Soviet heavy-handedness, the timing has been chosen with one eye on Berlin and the other on the 22nd Party Congress. Perhaps this is also the Soviet Union's answer to the discordant voice from its populous neighbor to the south.

As to the test itself, explosions of this size are not necessary for development purposes. As pointed out in a recent White House statement, "we believe the peoples of the world will join us in asking the Soviet Union not to proceed with a test which can serve no legitimate purpose and which adds a mass of additional radioactive fallout." If the Soviets proceed with such an unnecessary and possibly risky test, despite urgings to the contrary, we trust that this latest outrage will remove the doubts of even their most indulgent apologists among the non-aligned nations who failed to protest the Soviet resumption of testing during the Belgrade Conference.

Strengthening Survivability

Notwithstanding what the White House called the "unconfessed political purpose" behind this particular test, we must and we do take seriously the Soviet Union's military technology and the likelihood of future improvements in its nuclear strike posture. We are therefore increasing the survivability of our retaliatory force by programs of hardening, concealment and mobility.

We have accelerated deliveries of *Polaris* submarines and hastened the development schedule for a greatly improved version of the missiles they carry. We have expanded the development of the *Minuteman*—our solid-fuel, land-launched missile—and enlarged its production capacity. We are proceeding simultaneously with the development of

advanced air-to-ground missiles, such as the *Skybolt*, in order to extend the useful life of the manned bomber further into the missile age.

To protect the deterrent effect of our existing bomber forces, we have upped the number of planes on ground alert, and we are working to increase the dependability of our warnings against surprise attack by installing bomb alarm detectors and signals at SAC bases and other key points. Our planners are working on many other important research programs such as missile defense and penetration aids, satellite-based communication systems and possible military uses of space.

In the interest of protecting our civilian population from radioactive fallout, we have made a fresh start on a national shelter program under the aegis of the Department of Defense to which have been transferred important new responsibilities in the civilian defense field.

The weapons that form the backbone of our deterrent strength are formidable, and we intend to keep them so. But if we had no effective weapons but the big ones, a small-scale Communist aggression could confront us with a choice between the risk of general war and a political retreat.

Hence we are looking to the condition of our conventional forces, so that a potential enemy may not be tempted to steal from under our noses, gambling that we would not call out the weapons of massive nuclear destruction in response to ambiguous aggression or deliberate probing by the enemy.

Let me make clear that we are seeking to acquire flexibility rather than rigidity in the options open to us. This requires a strengthening of conventional, non-nuclear arms; it does not rule out the use of tactical nuclear weapons in a limited war if our interests should so require.

We are placing a new emphasis on our ability to meet limited and guerrilla warfare by expanding research on conventional weapons, improving air and sealift capacities for moving large numbers of troops to crisis areas on short notice, and increasing the procurement of the weapons of limited war. The substantial additional purchases of conventional weapons and equipment include tactical aircraft, tanks, rifles, personnel carriers, artillery and stocks of ammunition.

I might note here that our Military Assistance Program is designed to deal with aggression in its incipient phases, by helping friendly nations to improve their internal security and making local wars and forays against them unprofitable. Our assistance to our NATO allies should also help to deter general war.

As the pressures have mounted on Berlin, we have retained in service or reactivated ships and planes with tactical, troop-carrying or antisubmarine capabilities. We have at the same time started to draw on available manpower pools for substantial increases in the armed services totalling to date about 325,000 men, by extending active duty tours, stepping up the draft, and by recalling reservists to active duty.

These immediate measures are concerned chiefly with Berlin. No one can say how long that crisis will be with us, or where the next Soviet experiment in international anxiety may be scheduled. Probably we are in for a period of protracted tension and we are making our plans accordingly. Southeast Asia is currently under severe pressure, and other areas are not immune.

Obviously, it would be to the advantage of an adversary if we let him rush us into a succession of mobilizations and demobilizations according to his dictates. Instead, it is to our advantage to maintain a ready force of well-equipped regulars which can be augmented in a relatively short time by trained reserve forces.

Short of Fully Mobilizing

Accordingly, the Army's current goal is to ready a number of priority Reserve or National Guard divisions for call-up on not more than eight week's notice. This Army plan will, of course, require corresponding stocks of modern weapons and ammunition to be on hand, and the complementary air and naval units must be brought to active duty status with comparable speed.

This program of accelerated reserve training and modern weapons improvement is intentionally short of full national mobilization, but nevertheless gives us a very real addition to our forces in Europe. First, we and the other Western powers have agreed to bring up to full strength our present units in the Central European Theater.

At home, meanwhile, we are converting to combat readiness the three of our Army's 14 divisions previously engaged in training missions. Later this year, therefore, this country will have ready for immediate deployment six Army divisions and two divisions of Marines, plus the two National Guard divisions already recalled and any other reserves that may hereafter be ordered to duty. Thus, if the clouds over Berlin should darken further between now and winter, the Defense establishment could move to Europe on short notice six or more divisions, more than doubling, if need be, the potent American fighting forces currently assigned to NATO. Meanwhile, large amounts of military equipment and supplies are being prepositioned overseas.

Concurrently with the Army build-up, a number of Air National Guard fighter units have been recalled to provide the necessary air cover and support overseas, and the Air Force has also augmented its airlift capacity by canceling the deactivation of certain transport squadrons and calling up others.

For its part, the Navy is improving its amphibious transport, taking action to permit the assignment of a third carrier to the 6th Fleet in the Mediterranean, and extending antisubmarine patrols on the North Atlantic sealanes. The result will be a general strengthening of naval readiness around the world, thereby bolstering our national deterrent strength and contributing importantly to U.S. resources for limited war.

The Navy is constantly improving its vessels through modernization and the procurement of more advanced weapons systems. Nuclear submarines are entering the fleets in increasing numbers; guided missiles are replacing guns on destroyers, frigates and cruisers, and Mach 2-speed aircraft are operating from attack carriers.

Our present plan, as I have indicated, is to count on a ready reserve as a means of quick force augmentation in emergencies. The alternative, which has its advocates, would be a substantial increase in our permanent force levels. Let us take a look at the choice we face.

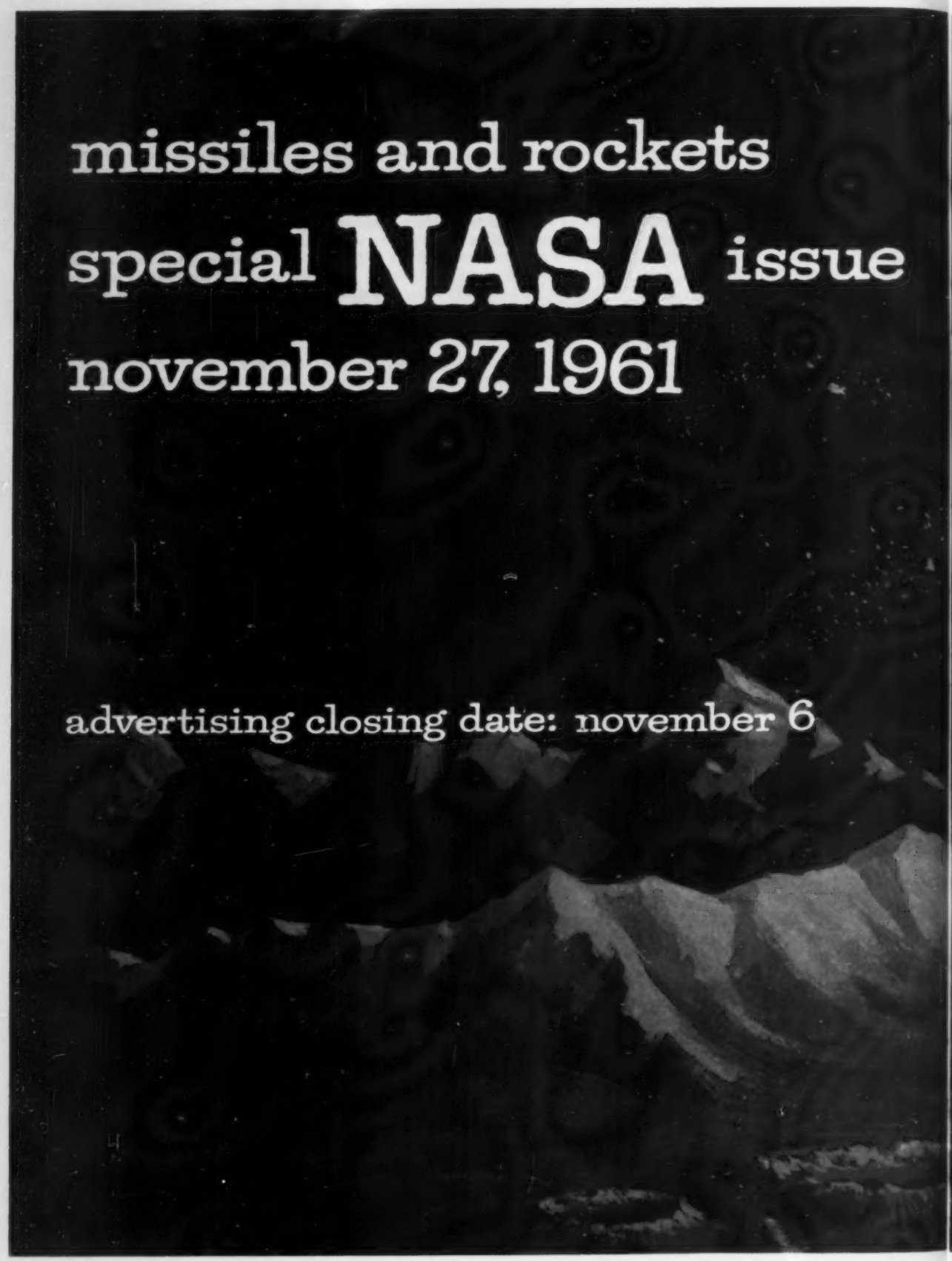
Unacceptable Alternative

For every fighting man added to our active military forces, the cost is at least $5000 a year just for pay and allowances, subsistence, clothing and transportation without counting the modern combat equipment he needs, ranging from infantry rifles to the latest in nuclear submarines. A larger standing Army would also mean greater overhead costs, in terms of more military installations and added administrative and support facilities. In the long run, as individual duty tours and enlistments are completed, training costs for replacements would also go up.

The ready reserve is much less costly to maintain. Members of reserve units are paid only for their weekly and annual training periods. The major items of equipment they require, such as air and sea transport, heavy artillery and tactical aircraft, need not be constantly exercised and can be provided by Air Force and Naval Reserve units when Army reservists are called to active duty.

In reviewing our current preparedness programs, which have already been brought up to record levels for non-wartime, we have asked ourselves whether we could buy enough extra protection by further enlarging our permanent forces to offset the added costs and disadvantages I have mentioned. The answer appears to be no.

We must ever be mindful, however, of the fact that the Moscow-Peiping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'The United States does not intend to be defeated . . .'

axis is capable of generating simultaneous crises in widely separated parts of the globe. The free world could conceivably be faced with critical situations at the same time in more than one area of the world. Should it prove necessary to deploy U.S. forces in support of two or more threatened areas, additional Reserve and National Guard divisions could be activated in order to provide impressive increments to our strength.

We recognize, of course, that divisions yet to be mobilized represent potential power rather than power in being. Were it to become apparent that to deal with multiple trouble situations a further increase in our permanent forces is needed, then the Congress will be asked to make the required resources available, and all of us will be called upon for new sacrifices of money, time and energy. Until that contingency occurs, our reserve program should give us strength and flexibility in the most economical manner.

Non-military Resources

As we hasten the build-up of our conventional forces, we might remind ourselves that, after all, the nations of the NATO alliance have more people, greater economic resources and further advanced technologies than all of the Warsaw Pact countries combined. Moreover, the Soviets may well have reason to doubt the military dependability of their European satellites in a showdown.

Summation

Let me sum up, then, where our defenses stand today. First, we continue to rely on our strategic nuclear weapons to convince a would-be aggressor that he could not emerge standing from a general war of his own instigation and we are keeping those weapons up to date.

Secondly, we are rapidly strengthening out conventional weapons and increasing our ready reserve of trained manpower, to give us an improved, third choice between all-out nuclear retaliation and retreat.

Thirdly, we are endeavoring to strengthen and improve the military defenses of our friends in the world in accordance with their needs, with special attention to preventing or confining limited wars, subversion and guerrilla-type insurgency.

We are determined to have flexibility in our choice and mobility of weapons, and in our capacity to respond to repeated crises in the long run without the dislocation of our entire economy.

The Soviet's bluster and threats of rocket attack against the free world—aimed particularly at the European members of the NATO alliance—must be evaluated against the hard facts of United States nuclear superiority which I discussed earlier. Although we are confident that we would ultimately prevail in a test of strength no matter at what level conflict might be initiated by the Soviet Union, this does not alter our determination to seek a peaceful solution to the world's problems.

Forcing Reds into Peace

But those who would impose a totalitarian world order and deny men and nations the right to pursue their own destinies should understand one point very clearly. The United States does not seek to resolve disputes by violence. But if forceful interference with our rights and obligations should lead to violent conflict—as it well might—the United States does not intend to be defeated.

As the President reminded the world at the UN last month, our country has both the will and the weapons to join free men in standing up to their responsibilities. We in the Defense Department believe that the proper exercise of our will and the development and management of our weapons will eventually force the Soviet Union to participate with us in a step-by-step program to guarantee the peace which so many nations earnestly desire. ¤

Analysis Shows U.S. Still Banks on Marginal Deterrence

(Continued from page 13)

compared to U.S. ICBM production was estimated to be running at a ratio of 3 to 1. And the Russians were estimated already to have several dozen diesel-powered submarines capable of launching approximately 200-mile-range missiles.

These were the intelligence estimates behind the expected Missile Gap. They were based for the most part on what the Russians were estimated to be capable of doing. If they were correct, the United States would face a period of great peril.

However, the estimates now have been revised downward. The estimates now credit the Soviets with only about 50 to 75 ICBM's today—instead of the expected 200 to 300. The estimates contend that the Soviets did not use their full ICBM-building capacity for one reason or another.

Therefore, if the new estimates are correct, Russia will not within the coming months have enough ICBM's to destroy SAC. And, on the basis of these estimates, Gilpatric can say: "We are confident that the Soviets will not provoke a major nuclear conflict."

But this is not because the United States has "tens of thousands" of nuclear delivery vehicles. It is because when faced with a potential bomber gap that failed to materialize in the 1950's, the United States "wastefully" built up its bomber fleet—and because the Russians are not believed to have built as many ICBM's as they were thought capable of building.

Through luck, the United States has apparently won a breathing space, a period in which it again has a chance to achieve a clearly dominant military position and assume the offensive in the Cold War.

Military strategists are advocating that the United States now outstrip the Soviets in the deployment of ICBM's, and at the same time beat or at least block the Soviet drive to make a possibly military end run in space.

So far, the Kennedy Administration is declining to do this.

The defense budget guidelines for FY '63 contain relatively little money for the development of military offensive and defensive space systems; the military contribution of the NASA *Apollo* program remains in doubt.

The budget guidelines also provide only for a relatively modest build up of the ICBM force beyond the numbers already authorized. The Navy may receive six more *Polaris* submarines. The Air Force may receive two more *Minuteman* squadrons.

But any plans that would make certain the building of a clearly superior U.S. force in the coming years have been put aside to await further intelligence reports on what the Russians may do.

The goal remains: Just retain the margin. ¤

Dearth of Electronics Experts Looms

DOD's Bridges warns that 40% gap will open in five years and will get worse; efficiency is the answer

by Bill Wilks

THE DEMAND for electronic engineers and scientists will outrun supply by 40% within the next five years.

James M. Bridges, Defense Department director of electronics, told the Los Angeles section of the Institute of Radio Engineers the situation "demands critical attention on a national basis."

Said Bridges:

"Around 120,000 of the estimated 155,000 electronics engineers and scientists in the nation are presently engaged in government-supported work. The planned expansion of the nation's space program, together with a continually growing defense effort will significantly increase the number needed in government work during the next several years."

The situation will get worse, he noted, because fewer electronics experts will be coming out of school in the next few years because of a drop in number of students entering that field four to five years ago.

Bridges told M/R he believes the only solution to the problem is to increase efficiency and productivity of the individual and the company, necessitating certain changes in attitude on the part of both, as well as a change in government approach. He made these observations and criticisms:

—"The push to create is not as great as it used to be. A young engineer now says, 'I don't want to do design work. I want to direct others in that.' Everybody wants to be a chief, not an indian.

—"There is instability among personnel in industry. Every time someone moves, there is an increase in salary. This is an incentive for a man to improve himself, not to increase his productivity.

—"I'm not sure industry as a whole is really aware of the seriousness of the problem. The government is—Secretary McNamara is. He is aware of the skyrocketing cost of engineering which has increased two-and-a-half times the cost-of-living increase in the last couple of years.

—"Contractors are putting more engineers on a job than they need. A contractor goes into a job without a thorough understanding of the schedule. We're not sure of cost and we don't review, so we stock a lot of engineers we don't really need. I'd break it into phases and review. We could go on a fixed price at a time when we can make a good estimate.

—"There is no real incentive, no real motivation for high efficiency. In defense work, the profit percentage is low. This is one reason why the incentive is so low. If we said, 'look, fellows, we'll give a better profit, 15 per cent instead of 3 per cent, and not renegotiate it down to zero, this would be a reward for high performance. Likewise, we've had no penalty for poor work.

—"We hear there is a lot of wasted effort writing proposals. This usually requires the most creative and talented people. This situation could be improved by the government not asking for proposals from companies that are not really capable of doing the work. Of course a lot of proposals are unsolicited.

—"We need better methods of checking contractors. I don't think we have a fine-grain way of doing this." ¤

RADIO CORP. OF AMERICA formed a data systems division in Van Nuys, Calif. The new division takes the place of the West Coast missile and surface radar division, and will handle all data systems activities.

FLEXIBLE TUBING CORP. and Kenyon Instrument Co. have merged through exchange of stock. Kenyon becomes a wholly-owned subsidiary of Flexible. The combined companies look for expanded activity in aerospace and marine fields.

MACHINE DYNAMICS INC. has been formed in Pasadena, Calif., to develop, design, and manufacture programed environmental test facilities. Programed systems include shock simulators, high-force vibration equipment, dynamic loading equipment, dynamic loading and pressurization facilities, and dynamic material evaluation machines.

TECHNICAL CONSTRUCTION CO. was established as a subsidiary of Ets-Hokin & Galvan, Inc., electrical contracting firm.

Financial Reports

COMPANY	PERIOD	INCOME		EARNINGS	
		1961	1960	1961	1960
Celanese Corp of America	9 Mo. Sept. 30	$206,885,003	$202,003,190	$13,732,223	$14,595,543
Douglas Aircraft Co.	9 Mo. Aug. 31	618,290,832	859,540,578	4,485,938	—21,868,045
Electronic Specialty Co.	9 Mo. Sept. 30	20,241,290	7,651,175	887,180	13,159
Elion Instrument, Inc.	Year, July 31	205,403	25,268	—224,108	—139,897
Espey Mfg. & Electronics Corp.	Year, June 30	5,139,089	3,696,853	189,495	172,490
FMC Corp.	9 Mo. Sept. 30	315,565,839	275,139,466	18,737,820	16,563,244
Hagan Chemicals & Controls, Inc.	9 Mo. Sept. 30	30,540,290	30,384,696	1,361,765	1,390,244
Minneapolis-Honeywell Reg. Co.	9 Mo. Sept. 30	333,846,759	312,806,497	16,312,254	18,358,826
Parker-Hannifin Corp.	3 Mo. Sept. 30	13,414,304	10,778,180	690,580	393,520
Radiation Inc.	Year, Aug. 25	26,244,383	23,155,845	587,839	184,787

NASA Hunts 'Unconventional' Rocket

NASA IS PURSUING the search for a radically new rocket to replace today's Goddard-based "Model T" design.

The space agency disclosed this week that Aerojet-General Corp. and Rocketdyne Division of North American Aviation Inc. are engaged in studies of new techniques of building large liquid rocket engines.

The 10-month contracts — worth $185,000 each—were awarded in April, 1961. Final reports are due in February 1962. Work on the proposals may then continue for several years.

NASA officials said that while the current program is merely in the study phase, "we do not expect a negative report." They said improvements in current large liquid rockets engines are necessary if the U.S. is to equal or surpass the Soviet Union in the space race. DOD is already supporting similar studies and the NASA program will complement that effort.

• **Cheaper, too**—Prime purpose of the new studies is to determine what types of "unconventional" engine and vehicle designs are feasible.

"Unconventional" is defined by NASA officials as an engine which does not use a de Laval nozzle, does not use gimbling for thrust vector control, and which has a better "alliance" structurewise between the engine and vehicle than current liquid rocket engines.

There are good reasons to believe, the officials said, that an unconventional engine which is rigidly mounted, but still provides vector control would be lighter, more reliable and cheaper than current rocket engines.

A lid of secrecy has been clamped on the engine concepts under consideration. Space agency officials said, however, that:

—The engines would be used in big boosters with 2 million to 24 million lbs. thrust. It is possible that use in upper stages could come later.

—Propellants for purposes of the studies are liquid oxygen/hydrocarbons and liquid oxygen/liquid hydrogen.

—The engine's thrust will be constant—not variable.

Among the engine concepts which are certain to be considered under the NASA program are Rocketdyne's expansion-deflection and reverse flow nozzle concepts and General Electric's plug nozzle proposal.

The "reverse flow" concept has been classified by the DOD.

The "expansion-deflection" nozzle, however, involves the expansion of the exhaust gases around the corner of a centrally located plug. The flow is then deflected by the wall contour of a conventional-appearing exhaust chamber, which is about half the length required for conventional engines in the same thrust level.

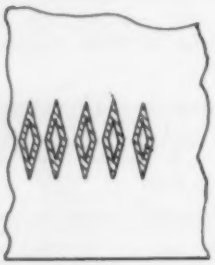
• **Plug nozzle in**—Rocketdyne says that the E-D nozzle incorporates such advantages as reduced weight and length, reduced cooling requirements, good performance at high and low altitudes, and possible simplified thrust vector control.

In GE's plug nozzle design, propellants would be ignited in a ring of small segmented chambers around the outside base of a large conical spike or plug. Unlike clustered rocket designs now under development, combustion cells would be designed specifically to be integrated into a single power package.

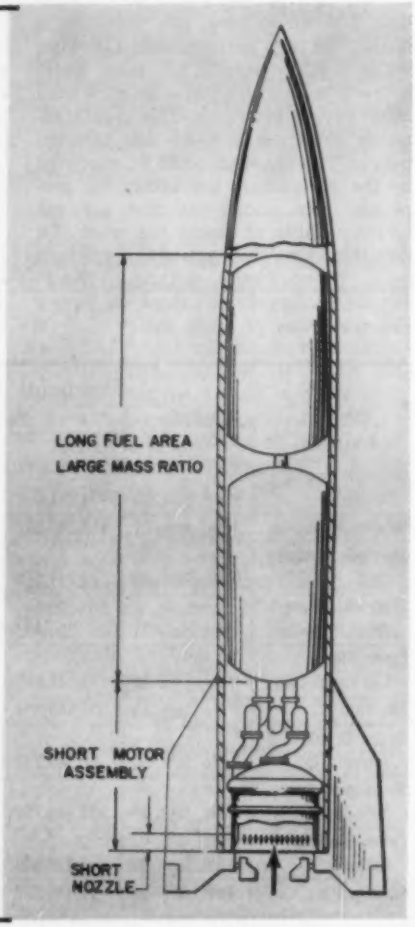
A large portion of the gas expansion would occur outside the thrust chamber. Since these supersonic gases would be self-adjusting, as surrounding air became increasingly rarified during rocket ascent, the configuration would be more effiicient at low altitudes than a conventional clustered engine like *Saturn*, GE contends.

Meanwhile, it was also learned that Dr. Werner von Braun, Director of NASA's Marshall Space Flight Center, has been awarded a patent on an unconventional rocket engine. He proposes to increase engine performance by cutting the size of the engine by removing the throat of the nozzle (see drawing). ⠿

Von Braun Patents 'Short Nozzle' Rocket



In a patent awarded earlier this year (No. 2,967,393) for a "Rocket-Propelled Missile," inventor Wernher von Braun claims devising a foreshortened rocket nozzle. Objectives are to get a vehicle with a high mass-ratio, more room for fuel tanks, and one whose combustion chamber and nozzle have cylindrical walls. Diamond-shaped tubes shown in cross-section (above) and in "short nozzle" (right), "are spaced from each other . . . by an amount sufficient to provide the proper nozzle throat area and mouth area." Missile is steered by carbon vanes in the exhaust.



New Product of the Week: Recorder Monitors Up to 40 Machines

A DESK-TOP-SIZE device that monitors and records the efficiency of utilization of up to 40 production or data-processing machines is being manufactured by Electronic Associates, Inc.

The bar chart recorder operates remotely from production areas and provides cost and production control information on a continuous-bar chart.

The unit provides management with an accurate graphic picture of each machine's productive and nonproductive effort. It can also provide such information as the operator number, job and shift number corresponding to any manual effort on the part of the operator.

Every 20 seconds the recorder samples and graphically records each machine's performance. If the machine is operating, the fact is recorded with a short horizontal line in the appropriate bar or channel area. Lines do not appear if the machine is idle. The recorder is available with charting time of 9, 17, or 24 hours per chart.

Circle No. 225 on Subscriber Service Card

Temperature Detector

A resistance temperature detector with resistance wires interwoven with fiberglass threads to provide a rugged, accurate and inexpensive sensing element is available from Control Indicating Corp. The detector is a ribbon-type with inherent design capability providing greater resistance per linear inch, ability to fit curved or irregular surfaces with almost complete absence of strain gage effects. The units are manufactured with either platinum or nickel wire and are suitable for use up to 1000°F.

Circle No. 226 on Subscriber Service Card

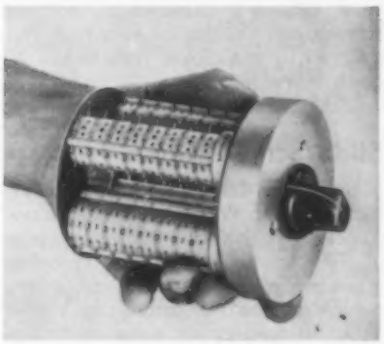
Programable Power

Carad Corp. is marketing a line of programable high-voltage regulated power supplies, suited to the requirements of automated checkout systems for testing electronic equipment and component assemblies. The d-c output voltage is programable over the range of 100 v to 3000 v by connecting an external resistor across a pair of terminals. The programing relationship is: output voltage = 100 v + .001 x programing resistance in ohms. Either polarity output terminal can be grounded. Output current range is 0 to 10 ma, with a current limiting circuit which operates at 12.5 to 15 ma. Output ripple is well below 5 millivolts rms, and the response time to a programing command for increased output voltage is 25 volts per millisecond.

Circle No. 227 on Subscriber Service Card

Interrogation Switch

A missile interrogation switch featuring any degree of indexing is available from Janco Corp. The Series 1900 miniature is ideally suited for incorporation into a gear-driven gang installation to provide a Series 2000 switch assembly having as many as 12 positions with



a total of 96 poles. Variations of this latest Janco switch with respect to total number of positions and poles are available. All switches can be readily adapted for remote solenoid operation. The switch is designed and built to exceed MIL-S-6807A. Because it is totally enclosed, it affords maximum protection against adverse conditions.

Circle No. 228 on Subscriber Service Card

D-C Torque Motors

Servo Components Division of Giannini Controls Corp. is producing a direct-drive d-c Torque Motor series for stringent military and industrial use.

Designed expressly for applications requiring a very high order of angular resolution and/or response at the load, a direct-couple torque motor eliminates the gear train with its inherent drawbacks of elasticity, back-lash and attenuation of response.

Standard models range from peak

torques of 20 oz.-in. to 350 oz.-in. Model DCTM 29-2 features peak torque of 60 oz.-in. with input power of 32 watts.

Circle No. 229 on Subscriber Service Card

Predetection Magnetic Tapes

Heavy-duty, high-resolution instrumentation magnetic tapes, created for wide-range predetection recording, are available from Minnesota Mining and Manufacturing Co. The tapes, named Heavy-duty Instrumentation Tapes Nos. 998 and 999, are extra rugged and capable of recording very short wave lengths. The 0.43 mil high-potency oxide coating is ultra-smooth, assuring faithful reproduction of very high frequencies, a paramount requirement of predetection recording.

Circle No. 230 on Subscriber Service Card

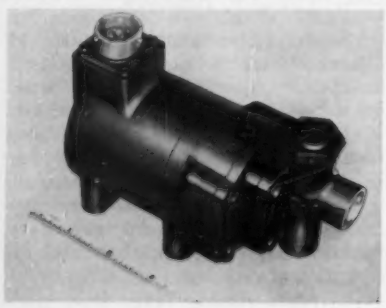
Slide Screw Tuners

Waveline, Inc. is marketing a complete line of Waveguide Slide Screw Tuners to cover the frequency range of 5.85 to 40.0 kmc. This complete series is a group of six standard catalog models designed for minimizing VSWR values in a waveguide transmission system. They are used primarily to match various microwave devices and to determine the position and magnitude of matching structures of new devices being designed in the laboratory.

Circle No. 231 on Subscriber Service Card

Cooling-System Pump

A pump for cooling systems on electronic and other precision equipment is available from Lear, Inc., Lear-Romec Division. The RG17400 is an electric motor-driven spur pump designed for operation in the new dielectric coolant fluids. The motor is a submerged type, to reduce weight and size in self-contained pump-motor assemblies. The RG17400 has an integral relief valve set to furnish flows from 1.5 to 2.5 gpm at pressures to 225 psi. Other models in the series have flows from 0.5 to 3.0 gpm and pressures to 400 psi.



Circle No. 232 on Subscriber Service Card

Polarized Relays

Small size, sensitivity and high speed characterize the MSI Polarized Relays available from Magnetic Devices, Inc. They provide wide selection of design parameters through almost unlimited combinations of coils, contact materials and arrangements, and adjustments in one compact size. One

or two coil units on 8-pin octal base, and three of four coil units on 12-pin plug-in base are available in side-stable, spring-biased and center-off configurations. Switching speed is on the order of one millisecond.

Circle No. 233 on Subscriber Service Card

Synchronous Motor

Kearfott Division, General Precision, Inc. is producing the T170-001 size 15 synchronous motor for use in such applications as ground support equipment, timing devices, recorders and wherever constant speed is required despite load or line voltage variations. The standard synchronous motors are 6-pole, 115-volt, 400-cycle units having a synchronous speed of 8000 rpm.

Circle No. 234 on Subscriber Service Card

Floated Gyro

A rate-integrating gyro that performs with a high degree of reliability even when subjected to high temperatures and radical changes in temperature is available from Lear, Inc. The Model 1078 floats in a capsule of special low-viscosity fluid that insulates the sensitive portions of the gyro from shock, vibration, and extremes in temperature. The floated feature also greatly reduces changes in bias drift and mass unbalance drift. The unit has proven its ability to perform reliably, both under laboratory tests and in actual missile flights.

Circle No. 235 on Subscriber Service Card

Semiconductor Sub-circuits

Utilizing a "match maker" process to meticulously select and closely mate component parameters, Continental Device Corp. is producing a line of high-reliability, packaged component assemblies. Named Compac Welded-Sub-Circuits, these devices feature close-tolerance, resistance welding of all intercomponent connections. Typical circuit-functions include: flip-flops, logic, voltage reference and regulation, demodulator, high voltage and bridge rectification. The circuit designer can select from four basic case styles; tubular, disc, rectangular or square, with a choice of lead configurations (axial, single-ended radial) and number of leads, in a variety of sizes according to his requirements.

Circle No. 236 on Subscriber Service Card

Tachometer Console

A tachometer test console designed to evaluate the operating characteristics of both the integrating and damping tachometers at a temperature range of −60° to 220°F is being marketed by the Instrument Division of American Electronics, Inc. The test console speeds up the testing process of the high-precision servo components by 800%. It

provides the test components with the temperature environment, excitation, and metering facilities to determine their transformation ratio, phase shift as a function of the operating temperature environment, linearity, and speed characteristics.

Circle No. 237 on Subscriber Service Card

Sinusoidal Oscillator

Solid State Electronics Co. is marketing a Model S-200 silicon transistor sinusoidal oscillator. The unit is completely epoxy encapsulated. Frequency stability as a function of supply voltage and temperature have been emphasized, toegther with rugged reliability. Power requirements are extremely low. This

oscillator makes possible the concentration of a large number of discrete control and information functions per unit volume and weight.

Circle No. 238 on Subscriber Service Card

Portable Punch Press

Modern Manufacturing Co., Inc. is marketing a portable punch press known as the Porta-Press that exerts 6000 lbs. but weighs only 17 lbs. Punch and dies can be easily replaced to punch out holes that are round, square, rectangular, or of any other shape up to ⅜ in. in diameter, up to 3/16 in. thick aluminum and ⅛ in. steel. This press can be used either as a portable or on assembly.

Circle No. 239 on Subscriber Service Card

Electronic Micrometer

An electronic micrometer precision-measuring system, which displays exact measurements to 10 millionths of an inch on a 5-digit counter and automatically plots the values on a chart recorder, is available from J. W. Dice Co. Readings are taken on a one-minute or any pre-selected time cycle. Micrometer head is temperature-compensated. Head, control unit and recorder may be located remotely from each other.

Circle No. 240 on Subscriber Service Card

A-C Voltage Standard

Tensor Electric Development Co., Inc. has announced the production of Model 6010 a-c voltage standard. This unit is said to be an a-c counterpart of the d-c standard cell. The application of the Model 6010 is as a voltage reference for a-c calibration work. At output voltage of 100v, accuracy is ±0.1%, output frequency 60 cps internal or 50-7500 cps with external ocs, output current up to 10 ma, input power 105-130v single phase a-c at 60 cps, size 8 in. H x 8 in. L x 6 in. D, weight 10 lbs.

Circle No. 241 on Subscriber Service Card

Detector Amplifier

A 5mc detector amplifier for wideband, frequency-modulated signals is available from Dynatronics, Inc. The model 5100 is designed for recovering PCM, PAM, and FM telemetry signals which have been detrodyned to a standard 5mc IF frequency. An integral part of the 5100 is a high-gain, wide-band d-c amplifier following the discriminator which is capable of driving a long 75 ohm coaxial line.

Circle No. 242 on Subscriber Service Card

Microwave Windows

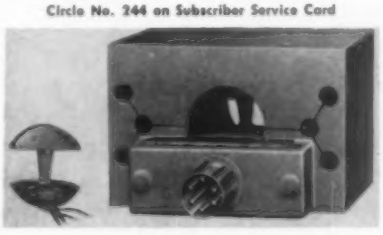
Ceramics International Corp. is producing ceramic microwave windows with metal window envelopes of various sizes. Special CI metalizing techniques eliminate the problem of braze joint overlap on the plane of the window. Extreme purity is maintained by contamination-free production methods. The windows are produced in sizes from 3/16 in. to 3 in. diameter, down to 0.010 in. thickness, and are available in rectangular and circular shapes.

Circle No. 243 on Subscriber Service Card

Force Measurement Device

A force measurement device is available from Flui-Dyne Engineering Corp. Known as the Flex-Cell, the unit accurately converts a particular component of force in a measurement system into an electrical signal. This is done without auxiliary mechanical or electrical devices for isolating the force or weight to be measured. The cell has low deflection and high frequency response. The unit safely wtihstands moment inputs.

Circle No. 244 on Subscriber Service Card



Pressure Research Unit

A self-barricaded high-pressure laboratory unit is available for research operations involving pressures to 5000 psi and temperatures to 650°F from Autoclave Engineers, Inc. Besides being self-barricading, the unit is easily movable, providing maximum flexibility in location. The unit is compact and fully equipped to include pressure vessels, valving, tubing and instrumentation, and is shipped ready for connection to existing utilities.

Circle No. 245 on Subscriber Service Card

Miniature Clutches

Precision Specialties, Inc., is marketing a stock series of miniature clutches that transmit up to 10 in.-lbs. of torque for coupling or through shaft applications. Clutches up to 200 in.-lbs. are available on special order. Units are simple in design for maintenance-free operation and provide a positive displacement drive. They operate up to 1800 rpm without lubrication, due to oil-impregnated, sintered alloy construction, and may run at higher speeds when lubricated.

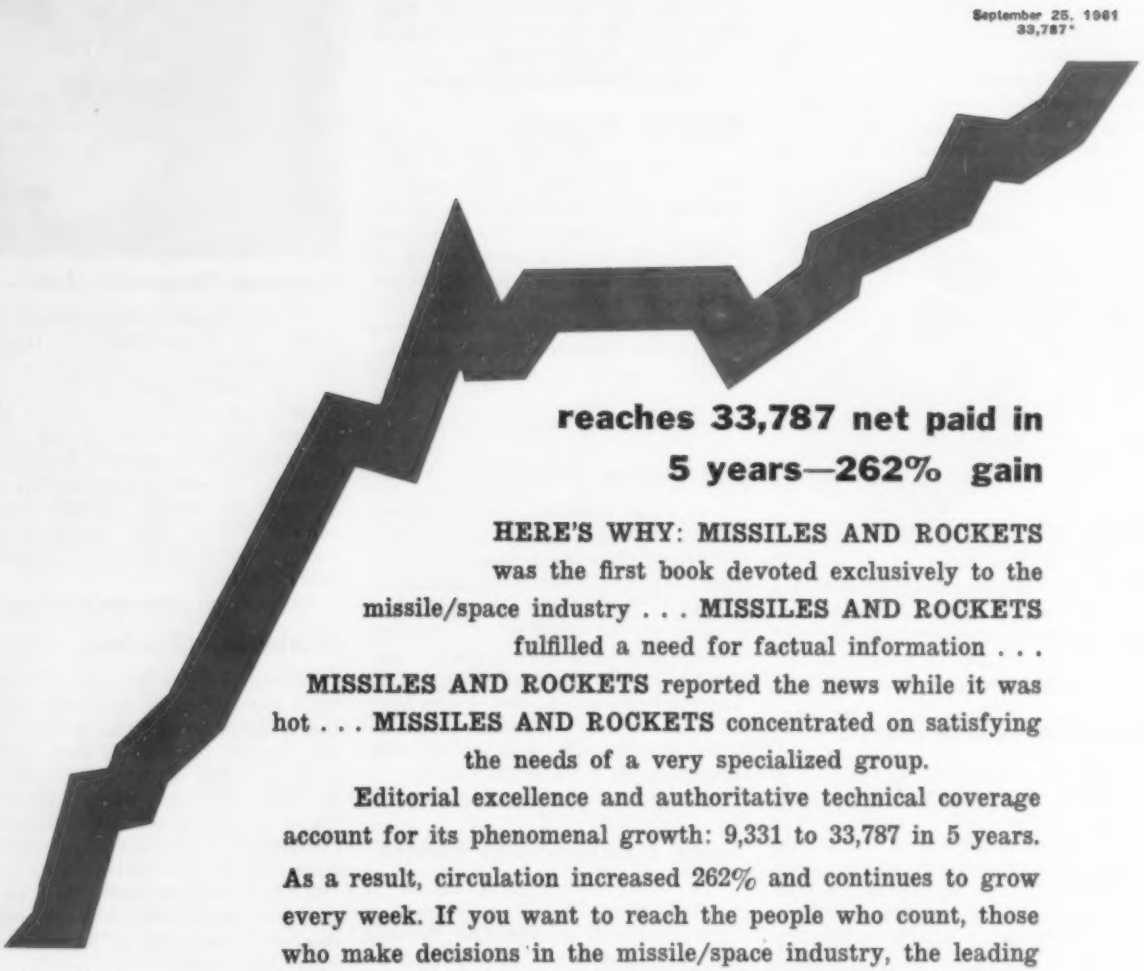
Circle No. 246 on Subscriber Service Card

Ceramic-to-Metal Housings

High-temperature ceramic-to-metal housings capable of withstanding temperatures to 1700°F are available from Advanced Vacuum Products. ADVAC rectifier housings have high metal strength and excellent dielectric properties, combined with a positive hermetic seal. Sheer strength in the order of 15,000 psi and thermal shock resistance at temperatures of 1000°F, coupled with high thermal conductivity, are characteristics of the vacuum seal, leak-tested 1 x 10^{-9} cc/sec.

Circle No. 247 on Subscriber Service Card

FASTEST RATE OF CLIMB



reaches 33,787 net paid in 5 years—262% gain

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missiles and rockets

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contracts

NASA

$19,000,000 — **Douglas Aircraft Co.**, Santa Monica, Calif., for 14 *Delta* three-stage rocket vehicles. (Company said about ⅓ of money will be distributed among subcontractors, principally **Aerojet-General**, which makes *Delta's* second-stage rocket.

$1,718,076—**Air Products and Chemicals, Inc.**, Allentown, Pa., from Marshall SFC, for construction of liquid hydrogen servicing system to be used in fueling upper stages of later *Saturn* vehicles launched from Cape Canaveral.

$1,000,000 — **Westinghouse Electric Corp.**, Pittsburgh, for an arc heater—most powerful ever made—and power supply for space program testing work at Langley AFB.

$73,000—**Military Electronics Div., Motorola Inc.**, Scottsdale, Ariz., from Jet Propulsion Laboratory, for blockhouse console control units for *Rangers 3, 4 & 5*.

NAVY

$10,900,000—**Westinghouse Electric Corp.**, for continued development of nuclear propulsion for Navy ships.

$3,000,000 — **Allegany Ballistics Laboratory**, Pinto, W. Va., for continued research on solid propellant to be used for *Polaris*.

$1,750,000—**Lockheed Missiles and Space Co.**, Sunnyvale, Calif., for *Polaris* static test vehicles.

$1,570,504—**Texas Instruments, Inc.**, Dallas, for engineering and manufacturing services to provide developmental guidance and control assemblies for *Shrike* air-to-surface antiradar missile system.

$1,315,000 — **Aerojet-General Corp.**, Azusa, Calif., for design and development of two sets of communications systems equipment.

$608,500—**Schaevitz Engineering**, Pennsauken, N.J., from **General Dynamics**, for accelerometers to be used on *Terrier* and *Tartar* missiles.

$360,000—**Cardion Electronics, Inc.**, Westbury, N.Y., from BuWeps, for weather radar equipment.

AIR FORCE

$8,360,000—**The Hallicrafters Co.**, Chicago, for production of countermeasures transmitting sets for B-52 bombers (two contracts).

$2,155,000—**Dynamics Corporation of America**, New York City, for engine power generator sets (may also be used as "stand-by" sources of electricity for such critical purposes as missile firings).

$1,181,368—**The Boeing Co.**, Seattle, for additional *Minuteman* missile assembly facilities at Air Force Plant 77, Hill AFB, Utah.

$675,000—**RW Div., Thompson Ramo Wooldridge Inc.**, Los Angeles, from **Cubic Corp.**, for six AN/UYK-1 "Stored Logic" computers for Radar Chain Acquisition System of Atlantic Missile Range.

$484,807—**Yardney Electric Corp.**, New York City, for silver-zinc batteries for *Bomarc* missiles.

$321,258 — **United ElectroDynamics, Inc., United AeroSpace Div.**, Los Angeles, from **The Boeing Co.**, for development and production of a digital telemetering system and various items of ground support equipment for operational *Minuteman* program.

$300,000 — **Texas Instruments, Inc.**, Dallas, from **Autonetics Div., North American Aviation, Inc.**, for follow-on orders of electro-optical instruments used in alignment of Autonetics' inertial guidance systems for *Minuteman*.

ARMY

$1,967,000—**Raytheon Co.**, Andover, Mass., for production of high-power radar illuminators for the *Hawk* missile system.

$990,000—**Melpar, Inc.**, Falls Church, Va., for research and development.

MISCELLANEOUS

$5,000,000—**Electronic Assistance Corp.**, Red Bank, N.J., from Maintenance Service Supply Agency (NATO) for electronic equipment.

$500,000—**United Technology Corp.**, Sunnyvale, Calif., from Navy and Air Force, for research in fundamental phenomena of combustion in new areas, dynamics of two-phase flow in rocket nozzles, and development of tubular nozzle systems for solid-propellant motors.

$400,000—**Infrared Industries, Inc.**, Waltham, Mass., from Navy, General Electric and **Flugeratewerke Bondensee GmbH**, for infrared detectors and optical filters for use in air-to-air missiles.

OPPORTUNITIES

National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md. Operate, maintain, and logistically support certain portions of the *Project Mercury* ground tracking stations.

The NASA/GSFC Procurement and Supply Div. has issued RFP VN-4275 for operation, maintenance, and logistic support services for five Project *Mercury* ground tracking stations located in Bermuda, Guaymas, Canary Islands, Keno and Zanzibar; O&M of the Wallops Island demonstration site; O&M of the test aircraft; engineering support for the entire *Mercury* network consisting of fourteen stations and the establishment and maintenance of a NASA depot for logistic support of "Mercury Tracking Stations."

Proposals are due to be received at the NASA Procurement Office, Goddard Space Flight Center, Greenbelt, Md., on or before Nov. 17, 1961.

The following firms have been invited to participate: American Hydrotherm Corp., Long Island, N.Y.—The Lummis Co., Washington, D.C., Attn: Marvin Marcus—The M & T Co., Philadelphia, Pa., Attn: Sam McKeegan—Radio Corp. of America, Camden, N.J., Attn: W. P. Davidson—Federal Electric Corp., Paramus, N.J., Attn: J. G. Mowder—Western Electric Co., Inc., New York City, W. H. Doherty—Lockheed Aircraft Corp., Burbank, Calif., Attn: W. G. Myers—Collins Radio Co., Dallas, Tex., Attn: M. A. Elbourn—The Bendix Corp., Baltimore, Md. —H. L. Yoh Co., Inc., Philadelphia, Pa.—Page Communications Engineers, Inc., Washington, D.C.—Vought Range Systems, Dallas, Tex.—Land-Air, Inc., Chicago, Ill., Attn: G. N. Johansen—Hughes Aircraft Co., Los Angeles, Calif., Attn: M. A. Zullo—Advanced Communications Engineering, Washington, D.C., Attn: H. P. Livingston.

It is suggested that small business firms or others interested in subcontracting opportunities on this procurement make direct contact with the above firms.

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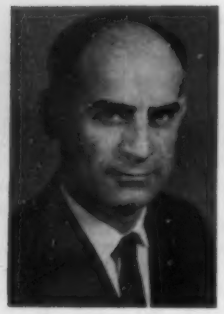

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J. Benham Malcolm: Named executive assistant to the president of Information Retrieval Corp. of Washington, subsidiary of Information for Industry, Inc., Washington, D.C. Malcom formerly was with Teleregister Corp.

Dr. Milton M. Klein: Plasma physicist and former consultant to GE's Missiles and Space Vehicle Dept., joins staff of Geophysics Corporation of America, Bedford, Mass., where he will be associated with studies of new space weaponry and nuclear explosion detection research.

Dr. G. J. Harbold: Joins the Life Science Dept., Naval Missile Center, Pt. Mugu, Calif., as Bio-Project Acoustics Director. The new post, established by BuWeps, involves high-intensity noise from naval weapon systems, missiles and aircraft, and the effects of this noise on hearing. The third facet of the job will be the establishment of a naval technical hearing school at Pt. Mugu. Dr. Harbold also will be a representative of the Bureau of Medicine and Surgery at Mugu.

H. E. Kurzweg: Formerly with Dage Div., Thompson-Ramo-Wooldridge, Inc., appointed applications engineer for Cohu Electronics, Inc., Kin Tel Div., Beverly Hills, Calif.

W. L. Whittier: Named vice president-deputy general manager; **J. O. Moxness,** vice president-commercial sales; and **Leo J. Devlin,** vice president-engineering and product development, at the aircraft division, Douglas Aircraft Co. **R. L. Johnson,** director of product development for the missiles and space systems division, made a division vice president. **J. R. Allen,** general manager of the Tulsa division, will be a vice president of that division.

Kenneth D. Christensen and **Harold L. Flowers:** Named proposal manager and general manager of engineering, respectively, in the Electronics Operation of Avco's Electronics and Ordnance Div., Evendale, Ohio.

Dr. Stanley Hills: Appointed to the staff of the Industrial Group, Electric Storage Battery Co., Philadelphia.

Dr. G. Lloyd Martin: Formerly assistant professor of chemistry, University of Alabama, appointed assistant general manager, Metals Div., National Research Corp., Cambridge, Mass.

Murray Falkowitz: Named manager, project management office: **James M. Harley,** manager, systems engineering dept., Reconnaissance Systems Laboratory, Sylvania Electric Products, Inc., Mountain View, Calif. **Edward G. Dooley** named aerospace products manager for Sylvania's Data Systems Operations, Needham, Mass.

Dr. Harry E. Weaver: Appointed manager of optical pumping and cryogenics research; **Dr. James T. Arnold** appointed manager of research in geophysics and space physics, Instrument Div., Varian Associates, Palo Alto, Calif.

David Saxe: Joins Atomics International, a division of North American Aviation, Inc., as manager of administration. He formerly was deputy manager, Chicago Operations office, Atomic Energy Commission.

Carl A. Georgi: Named assistant general manager, Friez Instrument Div., The Bendix Corp., Baltimore.

D. C. Arnold: Named chief engineer, Radio Corporation of America's Aerospace Communications and Controls Div., Defense Electronic Products, Camden, N.J. Prior to joining RCA, Arnold served as vice president, Alpha Corp., a subsidiary of Collins Radio Co. **Lawrence M. Falk** named manager, Support Engineering, Data Communications and Custom Projects Dept., in RCA's Electronic Data Processing Div., where he will be principally concerned with USAF's Combat Logistics Network.

Peter N. Lensi: Appointed vice president, Hummel Chemical Co., Inc., New York City.

Cmdr. L. E. Kirk, Jr. (USN-ret.): Formerly aide and special assistant for aviation to the secretary of the Navy, appointed assistant to the president of Fairchild Stratos Corp., Hagerstown, Md.

James F. Healey: Appointed vice president of Minneapolis-Honeywell's Aeronautical Division. Healey also is general manager of the division's St. Petersburg, Fla., plant.

Dr. Theodore H. Maiman: Elected vice president of Quantatron, Inc., Santa Monica, Calif. Formerly Dr. Maiman was director of the company's Applied Physics Laboratory.

Dr. Peter L. Nichols, Jr.: Former director, Space Sciences and Propulsion Div., Stanford Research Institute, appointed senior scientist of Aerojet-General Corp.'s solid rocket plant, Sacramento, Calif.

Richard A. Hagberg: Former controller and assistant to general manager Components Group, Litton Industries, promoted to vice president and general manager, Triad Transformer Corp., a division of Litton Industries. Prior to joining Litton, Hagberg was with Lockheed's Missile Division.

Richard P. Conniff: Former marketing manager, Avco's Research and Advanced Development Div., joins American Machine & Foundry Co.'s Government Products Group as manager of its Washington regional office.

Leonard A. Henry: Joins Washington Technological Associates, Inc., as manager, Industrial Planning. With the Naval Weapons Plant, Washington, D.C., for 33 years, he last headed the Program Division, Industrial Control Dept. **Robert E. Pyles** named WTA's manager of Quality Control.

Ralph L. Shapcott: Formerly with Daystrom, Inc., appointed general manager, GPE Controls, Inc., Chicago, a subsidiary of General Precision Equipment Corp. under operating control of GPI's Link Div.

Warren E. Racine: Appointed assistant to general manager, Traid Corp., Encino, Calif. Prior to joining Traid, Racine was with The Martin Co. at Vandenberg AFB.

Max E. Norman: Appointed head of Heavy Military Equipment Dept.; **Richard W. Knight,** head of Avionics and Electronics Dept.; and **Benton H. Brothers,** head of Chemical Operations Dept.—all in Armament Div., Universal Match Corp., St. Louis.

Integrated Microcircuitry

(Continued from page 32)

grated microcircuitry is the ability to evaporate active elements.

Two approaches show promise. The first is to deposit single-crystal semiconductor films onto the microcircuit substrate. In this case it is highly desirable to be able to evaporate the semiconductor material onto a foreign substrate which is a good dielectric.

Lear is currently evaporating N- and P-type germanium in single crystal form, and N-type silicon has been used. Since the single crystal is normally an N-type film, the P-type is obtained by co-evaporation of antimony. Point-contact diodes have been made with this film material, says Moore, and work is progressing on overlapping junction formation.

The second approach, which appears to be the more interesting, is the use of the tunneling phenomena , in extremely thin films (10 to 70 A). This work, says Moore, has been pioneered by Dr. C. A. Mead of California Institute of Technology and other organizations.

An ability to deposit active elements will have a substantial effect in reducing the production cost of the integrated microcircuit.

Lear is currently working on production equipment aimed at evaporating a number of microcircuits with one system pump-down. The production of a resistance pattern in a microcircuit is a one- or two-minute operation, but the pump-down for a single evaporation may take as long as two hours due to the necessity of heating the substrate and the holding fixture.

Moore says there is enough to be gained by using current, conservative state-of-the-art evaporation means to attain a 10-to-1 volume reduction without resorting to techniques which are, at this time, marginal. ⌘

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1961 Aero/Space Fluid Power Conference, seminar sponsored by Aero Hydraulics Division of Vickers, Inc., Pick-Fort Shelby Hotel, Detroit, Oct. 30-31.

Radio Fall Meeting, sponsored by PGED, BTR, RQC, EIA and IRE, Hotel Syracuse, Syracuse, N.Y., Oct. 30-31.

Aeronautical Systems Division, Air Force Systems Command, symposium on Aerothermoelasticity, (by invitation), Biltmore Hotel, Dayton, Ohio, Oct. 30-Nov. 1.

National Association of Corrosion Engineers, Northeast Regional Meeting, New York City, Oct. 30-Nov. 2.

American Society for Testing Materials, Pacific Area National Meeting, Olympic Hotel, Seattle, Oct. 31-Nov. 5.

NOVEMBER

68th Annual Meeting, Association of Military Surgeons of the U.S., Mayflower Hotel, Washington, D.C., Nov. 6-8.

Special Technical Conference on Nonlinear Magnetics, sponsored by IRE Professional Group on Electronic Computers, Professional Group on Industrial Electronics and the AIEE, Statler Hilton Hotel, Los Angeles, Nov. 6-8.

Seventh Conference on Radio Interference Reduction and Electronic Compatibility, conducted by Armour Research Foundation and sponsored by Army, Air Force and Navy, Illinois Institute of Technology, Chicago, Nov. 7-9.

Seventh Annual International Conference on Magnetism and Magnetic Materials, sponsored by IRE, AIEE, ONR and AIME, Westward Ho Hotel, Phoenix, Ariz., Nov. 13-16.

Kansas City IRE, Symposium on Electronic Systems Reliability, Hotel Phillips, Nov. 14.

National Society of Aerospace Materials and Process Engineers (SAMPE) Ceramics and Cermets, Bodies and Coating Symposium, Biltmore Hotel, Dayton, Ohio, Nov. 14-15.

Northeast Research and Engineering Meeting, IRE, Somerset Hotel and Commonwealth Armory, Boston, Nov. 14-16.

19th Annual Aerospace Electrical Society Display, Pan Pacific Auditorium, Los Angeles, Nov. 15-17.

First Conference on Medical and Biological Problems in Space Flight, Bahamas Conference, Nassau, Nov. 19-24.

Electron Devices Meeting, IRE, Shoreham Hotel, Washington, D.C., Nov. 20-21.

11th Semiannual Meeting and Midyear Conference of the Manufacturing Chemists' Association, Inc., New York City, Nov. 21.

ASME Winter Annual Meeting, Statler Hilton Hotel, New York City, Nov. 26-Dec. 1.

A Tribute to the X-15

DAWN on the California desert comes cold and clear. Throughout the night, a small group of dedicated men have worked over a squat, ugly shape with the attention of a mother to a deformed child.

Other, sleepy-eyed men tumble out of cars and huddle on the flight line. The group disperses. Jets whine and the mothership climbs aloft with the ugly child tucked under one wing. Chase planes follow the pair in an anxious pursuit through the pale light.

Long minutes follow. The early morning sun glitters off the planes high in the air. Then a pencil-thin line of white vapor is drawn swiftly across the sky. The spacecraft streaks upward under the fierce thrust of its own rocket engines.

North American Aviation's *X-15* is reaching for another record in a performance becoming so routine that the tremendous achievements of the Air Force-NASA-Navy program are all too often taken for granted.

Within the past month, NASA test pilot Joseph Walker has flown the rocket craft to a speed of 3920 miles per hour—almost six times the speed of sound. Air Force Maj. Robert White has piloted the *X-15* to an altitude of 217,000 feet, more than 41 miles above the earth's surface.

In the light of these most recent accomplishments, it is perhaps time for a nod of industry recognition to the team which designed, built and is flying this first piloted U.S. spacecraft.

Judged on speed alone, the *X-15* is not far behind the *Mercury* capsule which carried Alan Shepard along a ballistic trajectory in his widely acclaimed space flight. The fact that the *X-15's* pilot is in full command of his craft during flight makes this accomplishment even more remarkable.

The *X-15* program got its start in early 1952, when NASA directed its laboratories to study the problems likely to be encountered in flight beyond the atmosphere. A decision followed in favor of a manned research spacecraft.

A team was assigned by NASA in 1954 to determine the characteristics of such a vehicle. Navy and Air Force, meanwhile, were carrying out similar studies. NASA's proposal was accepted as a joint effort.

Invitations to bid on the craft were issued in December, 1954. Bids in the design competition were evaluated in late 1955; North American won the contract in December of that year.

Less than three years later, the first *X-15* was rolled out and delivered to flight test. Its initial powered flight came in late 1959.

Since that time, first with the smaller engines and then with the big XLR-99 engine, the *X-15* has compiled a remarkable record of accomplishment, attaining an order of reliability which is extraordinary for a research project of this type.

The knowledge gained by the missile/space industry in advanced materials manufacturing, flight control design, rocket motor development, high-temperature stresses and human factors is a significant tribute to the *X-15* program.

MAJOR CREDIT for success of the program must go to North American. But more than 300 other firms share the credit.

The XLR-99 and XLR-11 rocket engines developed for the program by Thiokol's Reaction Motors division have played a large role in the success of the program—in an area which was pushing the state of the art.

General Electric developed the APU's; Garrett Corp. manufactured the liquid nitrogen cooling and pressurization system; David Clark Co. produced a new pressure suit for the program.

International Nickel Co. developed Inconel X to withstand the high temperatures. Bell Aircraft supplied the ballistic control rockets. Sperry Gyroscope developed an in-flight electronic indicator system; Lear produced a special three-axis indicator to show the attitude of the *X-15* in relation to the earth.

The grip for the control stick was manufactured in Van Nuys, Calif.; the electrical heating element for the nose probe came from Middletown, Conn.; a specialized voltmeter used for checking the electrical system was manufactured in Plainview, N.Y.; the explosive bolt used for separation of the lower vertical stabilizer before landing was produced in Hollister, Calif.

The human factors phase of the *X-15* program has been one of the most extensive in industry history. Even prior to flight testing, pilots and equipment were subjected to scores of tests in the USAF Aeromedical Laboratory at Wright-Patterson AFB. Maximum g forces were simulated in the Naval Air Development Center at Johnsville, Pa. Wind-blast tests were carried out on the sled track at Edwards AFB. Parachutes were tested at Navy facilities at El Centro, Calif.

The *X-15* program, initiated in early 1952, has cost somewhere in the neighborhood of $120 million for three flight vehicles. There also have been large indirect costs.

The development program has extended across all phases of the missile/space industry and involved NASA, the Air Force and the Navy. Knowledge obtained from the *X-15* flights will be just as widely distributed.

We salute the men who designed and built the *X-15* and the pilots who have flown it. U.S. spacemen for many years to come will owe them a great debt.

William J. Coughlin

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GESAC has already been successfully flight-tested aboard the Convair F-106 under Navy Bureau of Weapons sponsorship. An evaluation of extremely rigorous re-entry profiles has been conducted on the North American/NASA X-15 Simulator under Air Force contract, with outstanding success. A flight evaluation on the McDonnell F4H-1 is currently in progress under Navy BuWeps contract. GESAC provides another example of Light Military Electronics Department leadership in aero/space electronics.

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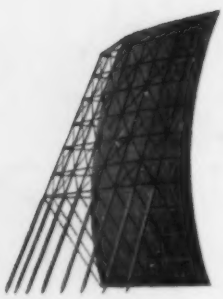
A decisive move was made late in 1960: the first BMEWS (Ballistic Missile Early Warning System) radar station began operating at Thule, Greenland. This system keeps a 24-hour vigil against aggression by enemy ICBM's. Huge klystrons produced by Varian are the heart of the BMEWS transmitter sub-system. The powerful tubes generate radar signals—sent from antennas big as football fields—to seek out possible airborne intruders.



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